The California Central Coast Research Partnership: Building
Relationships, Partnerships and Paradigms for University-Industry
Research Collaboration

FINAL REPORT ON ONR GRANT NO. N00014-01-1-1049
PERIOD PERFORMANCE: 9/9/01 to 12/31/02

March 25, 2003

Appendix A

TELECOMMUNICATIONS ASSET MANAGEMENT IN
A GLOBAL ENVIRONMENT

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TELECOMMUNICATIONS ASSET MANAGEMENT IN A GLOBAL ENVIRONMENT

Funded by Office of Naval Research Grant to the

The California Central Coast Research Partnership (C^{3}RP)

September 9, 2001 --- September 8, 2002

Volume 1

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Telecommunications Asset Management in A Global Environment

Project Report

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September 8, 2002

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Preface

This report is the product of a grant award originating from Office of Naval Research solicitation BAA00-018 (CPSU Grant Proposal Number 02-007) entitled "California Central Coast Research Partnership" awarded to the Research and Graduate Programs office at California Polytechnic State University, San Luis Obispo, California.

The mission of this project is threefold:

- To develop a blueprint or design concept for a telecommunications asset management environment that identifies, tracks, and codes global communications assets, brings them into services, and makes them available to complete specific time, service, and technology dependent use.

- To develop and implement an Asset Inventory prototype to gain a deeper understanding of the issues and complexities of designing, developing, implementing, and maintaining the data associated with managing assets in a complex telecommunications environment. In addition, provide a simple working application to record and track early asset donations, donors, stewards, and participants based on Activities and Operations of the Internet Educational Equal Access Foundation (IEEAF); See Attachment A for a description of the IEEAF Activities and Operations.

- To ascertain academic and research opportunities related to the technology that have potential in the California Central Coast Research Partnership (C^{3}RP) proposed for the Cal Poly State University campus.

The period of the grant was from September 9, 2001 through September 8, 2002.

Executive Summary

This is the final report of the asset management system project team. It is primarily a description of a vision for a comprehensive telecommunications asset management system as well as a report on the activities of the asset management team[1] from September 9, 2001 through September 8, 2002.

Vision

The vision of this effort is in support of a high bandwidth network environment used to manage a unique set of proprietary assets. The network assets will offer a level of service not available through the commodity Internet. The report contains the details of a framework for a fully functional Asset Management System that will offer a range of functionality consisting of processes that support:

- The initial capture of asset, donor, vendor, participant, and steward information at the core
- The rapid configuration of connectivity for a variety of users at a high level, in particular academic and research institutions in the IEEAF model, and
- Support of the user via a global network operating center that includes the ability to schedule and contract for use of assets

In keeping with the vision, a phased development approach is described that starts with key functionality and works outward. Ultimately, it is envisaged that the Asset Management System (AMS) will be capable of handling full "end to end" connectivity among geographically dispersed sites via a mix of donated, procured, and external assets.

Thus, in the IEEAF educational model, a U.S. based educational institution (such as a high school) could order high bandwidth video connectivity with a counterpart institution in Japan for a specified period of time. The AMS would identity the relevant internal and external assets and configure the connectivity in a timely manner. In addition, the system would handle the routine accounting functions associated with asset transactions as well as the monitoring and maintenance of an active wide area network. The complete system would contain state-of-the-art user interface components such as visualization tools that support visual "drill down" (zoom) from a high level map view to a detailed asset view. Various technical approaches are described in the report. These requirements might be implemented via a mix of custom architectures, commercial off-the-shelf (COTS) products, or a hybrid. The primary challenge is to specify an environment that encompasses the disparate business processes of accounting, tax reporting, asset configuration, monitoring, and maintenance.

Methods of Investigation and Analysis

The following are approaches used to gather information for the project:

- **Research Materials**

    o   Gartner Group Research Papers
    o   Peregrine Best Practices in Asset Management
    o   Telecommunications industry web sites
    o   Telecommunications industry periodicals and reports

- **Interviews**

    o   Internet Educational Equal Access Foundation (IEEAF)
        Discussions concerning the business processes and rules associated with accepting and managing telecommunications assets (Jerry Hanley, Treasurer and Asset Manager, IEEAF)

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[1] Dr. Ken Griggs and Dr. Jim Sena (both from the College of Business at CalPoly) and Joanne Temple, Consultant to ITS, CalPoly

- o Cal Poly Help Desk & Telecommunications Operations (Lygia Smidt, Information Technology Consultant, James Field and Ed Bruns, Network Analysts)
  Discussions concerning the help desk, network management, and monitoring software

- o Georgia Tech (Dr. Steven French, Director, Georgia Tech Center for Geographic Information Systems; http://maps.gis.gatech.edu/telecomweb/)
- o Discussions concerning the development and use of GIS systems as part of the Georgia High-Speed Telecommunications Atlas project at Georgia Tech

- o Internet2, Arena Pathfinder Project (The Advanced Research and Education Network Atlas project http://arena.internet2.edu/)
  Discussions concerning the development of the network map database that in the Pathfinder Project

- o GEOgraphic Network Affiliates-International, Inc. (Staff; http://www.geo-usa.com/)
  Discussions concerning the development and use of TradeBandwidth software for the brokering of bandwidth

- **Site Visits**

  - o Indiana University, Telecommunications Division and Abilene Network Operations Center[2]
  - o Collaborative Agent Design Research Center at Cal Poly[3] and CDM Technologies Corporation[4], San Luis Obispo, California
  - o Lockheed-Martin Corporation Network Operations Group in Santa Maria, California[5]

- **Product Demonstrations and Reviews**

  Asset Management
  - o Maximo 5 (MRO Corporation)
  - o AdventNet
  - o Mycroft Systems Aperture
  - o MainControl (now part of MRO Corporation)
  - o Autotrol Corp (Konfig)
  - o TradeBandwidth

  Help Desk & Network Operations Center Solutions (additional material included in binder)
  - o Remedy Corporation (now part of Peregrine Systems)
  - o System Management ARTS Incorporated (SMARTS)
  - o INTERNET2

  Donor Systems
  - o BSR Advance System (SunGardBSR)

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[2] Indiana University Network Operations Center and GlobalNOC (http://www.abilene.iu.edu/)

[3] Collaborative Agent Design Research Center, http://www.cadrc.calpoly.edu/. Collaborative Agent Design (CAD) Research Center, California Polytechnic State University • San Luis Obispo, CA 93407, USA Tel: (805) 756-2841

[4] CDM Technologies (http://www.cdmtech.com/)

[5] Lockheed-Martin Mission Systems, 1111 W. Betteravia Road, Santa Maria, CA 93455-1120 (www.lmco.com)

- **Systems Analysis**

  Business process and data models were created. Details of the process analysis are described in a later section.

- **Prototype Development**

  An operational prototype was created capable of capturing donor, gift, steward, participant, and asset information.

Results

A variety of existing systems consisting of a mix of custom architectures, COTS products, and hybrid systems were examined. It became apparent from the outset that no existing systems and approaches were sufficient to provide the envisioned level of functionality. Therefore, a set of unique requirements had to be developed that would encapsulate all of the appropriate functionality. In effect, the project team was tasked with developing a focused solution for a global telecommunications asset management resource. Such a resource has a distinctive set of reporting, tax, control, management, and performance monitoring issues. Thus, much of the report is devoted to fundamental systems analysis and design.

The final deliverables consist of:

- A set of requirements and design considerations for the future
  - Business process analysis
  - Best practices analysis
  - User requirements
  - A set of design alternatives
  - A set of design issues that will drive future development
  - A discussion of existing commercial off-the-shelf (COTS) products
  - A five version asset management system design consisting of increasing levels of functionality
- A prototype application
- An analysis of the research possibilities for the California Central Coast Research Partnership C3RP from both a faculty and student perspective

Introduction

This report consists of a set of requirements for a telecommunications asset management system (AMS) that identifies, tracks, and codes global communications assets, brings them into services, and makes them available to complete specific time, service, and technology dependent use. The Internet Educational Equal Access Foundation (IEEAF) Activities and Operations, as described in Attachment A of this document, provided a context for the global model. As a model, the IEEAF telecommunications inventory represents a wide mix of assets consisting of carrier hotel space, dark and lit fiber, conduit space, and wide area network access. Their donations (and procurements) are not limited to these items and may consist of virtually any type of telecommunications asset.

Purpose and Scope

The purpose of the research project is to create the software, database related technologies, intellectual property, and management strategy to facilitate efficient utilization of selected communications assets leased, owned or potentially available from donations, incentives, or procurements so as to significantly reduce the cost to the end-user. The system will contain the means to locate, track and broker the fair uses of current or potential assets. In addition, an end product of the research is the creation of a business model that would encourage the utilization and useful access of large-scale donated or procured network resources for educational purposes, the commercial marketplace, or government entities. It will employ "best practices" to enable appropriate access by the stakeholders. The scope of the project consists of the following deliverables within the 2001/2002 funding period:

- The development of a design concept or "blueprint" for a fully integrated Asset Management business model and Information System that addresses the basic objective of the grant including the capability to identify, track and code global communications assets, bring them into service, and make them available to complete specific time, service, and technology dependent utilization.

- The development of a prototype Asset Inventory module that provides a deeper understanding of the issues and complexities of designing, developing, implementing, and maintaining the data associated with managing assets in a complex telecommunications environment. In addition, provide a simple working application to record and track early asset donations, donors, stewards, and participants based on Activities and Operations of the Internet Educational Equal Access Foundation (IEEAF); See Attachment A for a description of the IEEAF Activities and Operations.

- The long-term feasibility for continued research, development, and a "Center of Excellence" in Asset Management in the Research Park.

This effort was limited to one-year contract duration from 9/9/01 to 9/8/02.

The Problem

The management of telecommunications assets poses a set of unique managerial and technical challenges. Telecommunications assets are "virtual" in that they may be created (configured) for a period of time and then disappear. Unlike typical fixed assets, telecommunications assets have the following characteristics and issues-

- Time value

  Some telecommunications assets conform to simple valuation measures but bandwidth, in particular, is problematic. Bandwidth, like airline seats, is a perishable commodity. Its value may vary by all time factors including time of day, day, month, year as well as time zone. In addition, bandwidth consumption may be "bursty" in the sense that its use is subject to wide swings in demand with the possibility of saturation. Thus, bandwidth management will require a new set of tools to model and

manage the resource partly based on time. New methods of accounting and econometric modeling will be required to exercise financial control, performance, and tax reporting.

- Location value

  The geographic location of telecommunications assets is an essential determinant of their value. From a research standpoint, the development of models, tools and techniques that assist in positioning assets would add value to the process. Position factors include-

  o Interconnection richness

    The value of telecommunications assets is enhanced when interconnection possibilities increase. A telephone is only as valuable as the number of telephones to which it can connect. Thus, the value of carrier hotel space is increased as interconnection equipment is added to it.

  o 'Last mile" positioning

    The location of assets such as carrier hotel space, wireless nodes, interconnection equipment, etc. may determine their value when they are close to end user points of demand.

  o International positioning

    Assets positioned at international demand points have value based on such factors as the ability to support the configuration of long haul/wide area networks, protocol translation, and global levels of support.

- Variable value based on market factors and technology

  The current telecommunications landscape is unique in history. The current overbuilding of telecommunications infrastructure and the accompanying decline in value can best be compared to the overbuilding of the rail system in the 19th century in England. It took almost half a century to consume the existing rail capacity. The decline in value is further complicated by increases in capacity due to advancements in technology. For example, increasing innovation in dense wavelength division multiplexing (DWDM) has lead to market dislocations. Without having to lay new fiber, the effective capacity of existing fiber plant can routinely be increased by a factor of 16 or 32. Thus, a fiber asset may increase in capacity but decline (or increase) in value greatly over time. This will require new accounting methods to accurately report asset values, deprecation, etc. From a system management standpoint, the dynamic addition of capacity increases the level of complexity and will require new tools and techniques.

- Legal and policy factors

  The current telecommunications environment contains an intricate mix of legal and policy factors. New technologies are forcing the redefining of law and policy in the area of copyright, privacy, and intellectual property rights as well as major regulatory changes.

  In a larger sense, the management of telecommunications assets will include such issues as technology transfer agreements, domestic and international joint ventures, and a wide variety of contracts unique to the telecommunications industry, such as indefeasible right of use (IRU) and building access agreements, shared resource fiber optic telecommunications contracts with state agencies, etc.

For example, assets might include any of the following legal arrangements-

- o Contracts with state agencies for the installation of fiber optic facilities on interstate and state highways
- o Fiber optic leases and IRU agreements and right of way agreements for telecommunications facilities
- o Telecommunications tower and antennae leases/approvals
- o Technology transfer agreements, patent licenses, know-how licenses, and vendor type agreements
- o International joint ventures agreements/leases, etc.

Assumptions

It is expected that the telecommunications entity organization will obtain sufficient assets such that the asset management system will represent the core functionality of a larger network operations center capable of connectivity, configuration, scheduling, and management. In addition, the following technical assumptions were made:

- A relational DBMS is the data structure of choice for all entity and process related data.
- Both internal (owned and configured by the institution holding the assets) and external assets (other networks with connectivity to the specific telecommunications manager's assets) must be represented but external assets would not have the same granularity as internal assets. Information on external assets must be sufficient to support end-to-end connectivity for users. Thus, for connectivity configuration purposes, some form of reference to external assets must exist but the actual use of these assets would require manual configuration. For example, internal carrier hotel space might be connected to another carrier hotel space through an external carrier. Only limited external information will be represented in the proposed system.
- Although connections to other networks would be enabled, network-operating facilities would be centralized. In short, there would be only one network-operating center; however, Help Desks may be distributed.
- The system must be scalable.
- The system must be capable of interfacing with applications such as a Financial Information System.
- The global nature of the asset management system dictates consideration for standardizing time, currency, and language or the ability to translate each.
- The concept of "stewards" who are (in most cases) geographically near the assets that they manage
- The system (in its final form) will be web-enabled and this should be a consideration in early development.

Analysis

Organizational Entities

As part of the initial systems analysis effort a variety of stakeholders, roles and relationships were identified.

The Telecommunications Bandwidth Manager: The Telecommunications Bandwidth Manager (TBM) owns or has oversight for configuring and maintaining a set of high bandwidth assets as useful and accessible telecommunications assets for part of the global community and the means by which the users or customers it serves can schedule and utilize the assets. In the model used, the TBM delegates direct management of the asset to regional Asset Stewards based on geographic proximity to the assets and vested interest in the particular community they serve. The TBM has responsibility for financial integrity through accepted accounting practices, appropriate tax reporting, usage monitoring, and reporting. In the IEEAF business model, donated telecommunications assets are managed on behalf of the global educational community with special reporting requirements to its donors. The AMS is expected to provide the TBM with the means to receive, record, operate and administer the telecommunications

assets with minimal operational and administrative costs through e-commerce and other "best business practices".

Donors (IEEAF Business Model): Individuals or corporations who determine they are positioned to gift to the IEEAF telecommunications assets to benefit the education and research segments of our society at no or little cost. Gifts may be by title to or a right-to-use for a specified period. The donor may have certain terms and conditions on the gift to which the IEEAF must agree. The asset management system (AMS) will provide a secure environment for the donor to apprise the IEEAF of a pending or pledged gift and, when finalized, to provide the IEEAF with the detailed asset attributes relevant to the acceptance, configuration, and operation of the donated asset or assets. The AMS will support the terms and conditions of the donation, attributes of the donation agreement itself, and critical financial information related to the gift. The donor will benefit with tangible visibility and demonstration that the donations made are configured and operational in a global telecommunications network for educational and research access and that the expected outcomes are being achieved.

Vendors: Suppliers of procured or licensed assets or services (not donated) requiring invoice and payment documentation. Particular attention must be paid to assets procured through license or IRU to meet the terms and conditions of use, agreement expiration dates, etc.

Asset Stewards: The Asset Steward is an organization that is a practicing operator of networking services or facilities that serve some portion of the US domestic or global community or others that directly do so. The Asset Steward has the competencies and resources to place the telecommunications assets into useful service, to sustain those assets subject to the terms of an Asset Stewardship agreement, and to make them of direct usefulness to promote efficient connectivity. The AMS maintains and tracks the terms and conditions of the Stewardship Agreement and the particular assets associated with that agreement. The physical descriptions and related agreements (warranties, maintenance, etc.) of the assets are available to the Steward for inquiry and maintenance of current condition and configuration. Participant Affiliate agreements, asset restrictions or conditions of use, and operating network status will be available to the Steward to support management decisions and operational support.

Participant Affiliates: Entities directly related to the TBM who are the defined beneficiaries of the assets with enhanced access to high-speed bandwidth within the mission and scope of the TBM. In the IEEAF model, these are global educational and research institutions that require high-speed bandwidth for teaching, learning, and collaboration. The situation would be analogous for other public and government agencies such as a branch of the Armed Forces. The AMS is expected to provide these end-users or Participant Affiliates with the ability to view telecommunication assets and available commercial alternatives for route segments not covered by the TBM networks, to make decisions based on speed and costs of commercial segment alternatives, and to schedule the global telecommunications resources "as-needed" at no or little cost through the Internet and to be assured that those assets will be available to meet their requirements.

Non-Affiliated Participants: Private or public sector entities that contract to use some portion of excess telecommunications bandwidth or other asset capacity on a fee basis.

Government Entities, Auditors, IRS: Government agencies that require reports and may have review and/or audit authority. For example, the IEEAF is established as a non-profit educational foundation (501 foundation) and is subject to IRS review and audit. Internal auditors are those engaged by the IEEAF to perform audit services.

C³RP: The C³RP has no direct relationship to the IEEAF and the other stakeholders at this time. The C³RP may benefit as the development of the AMS evolves, the need for administration and management of appreciating network assets increases, and operational network management on a global basis emerges as one of the key business processes of the IEEAF. The advancement of new technologies or the application of existing technology to the AMS may attract research and development tenants to the Research Park interested in leading the direction for an AMS that addresses all of the business processes identified in this document, benefiting the telecommunications industry at-large, and providing opportunities for Cal Poly students to participate in the research and development.

ONR/DOD
The Office of Naval Research, Department of Defense has expressed interest in and provided grant funding to Cal Poly and for research and development in the area of telecommunications assets management.
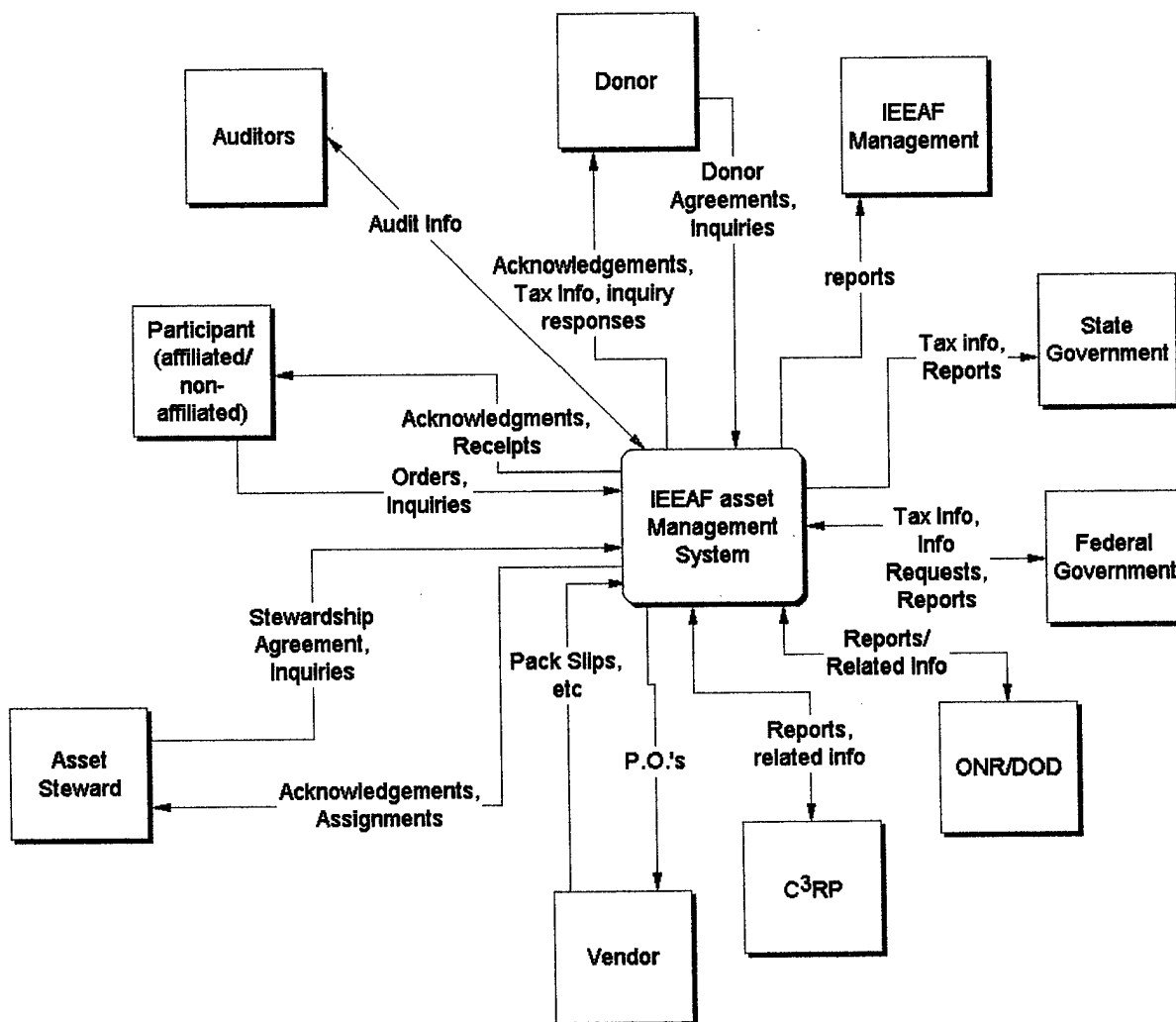
Diagram 1: Context Level View of the Organizational Entities For the IEEAF Business Model

Business Processes

A primary goal of the project was to develop an understanding of the fundamental business processes (BP) in telecommunications asset management. The above mentioned analysis methods (interviews, site visits, software evaluations, etc.) were used to develop a comprehensive model of processes and workflows required by the problem. A traditional data flow diagram approach was employed to create a visual representation of the essential processes, flows, data stores, and external entities that constitute a logical representation of the system. A well-developed model contains those processes that are essential and implementation independent. These processes must be contained in any implementation. See Attachment C for a simple list of the Business Processes. The following process descriptions and diagrams form the basis for all system development.
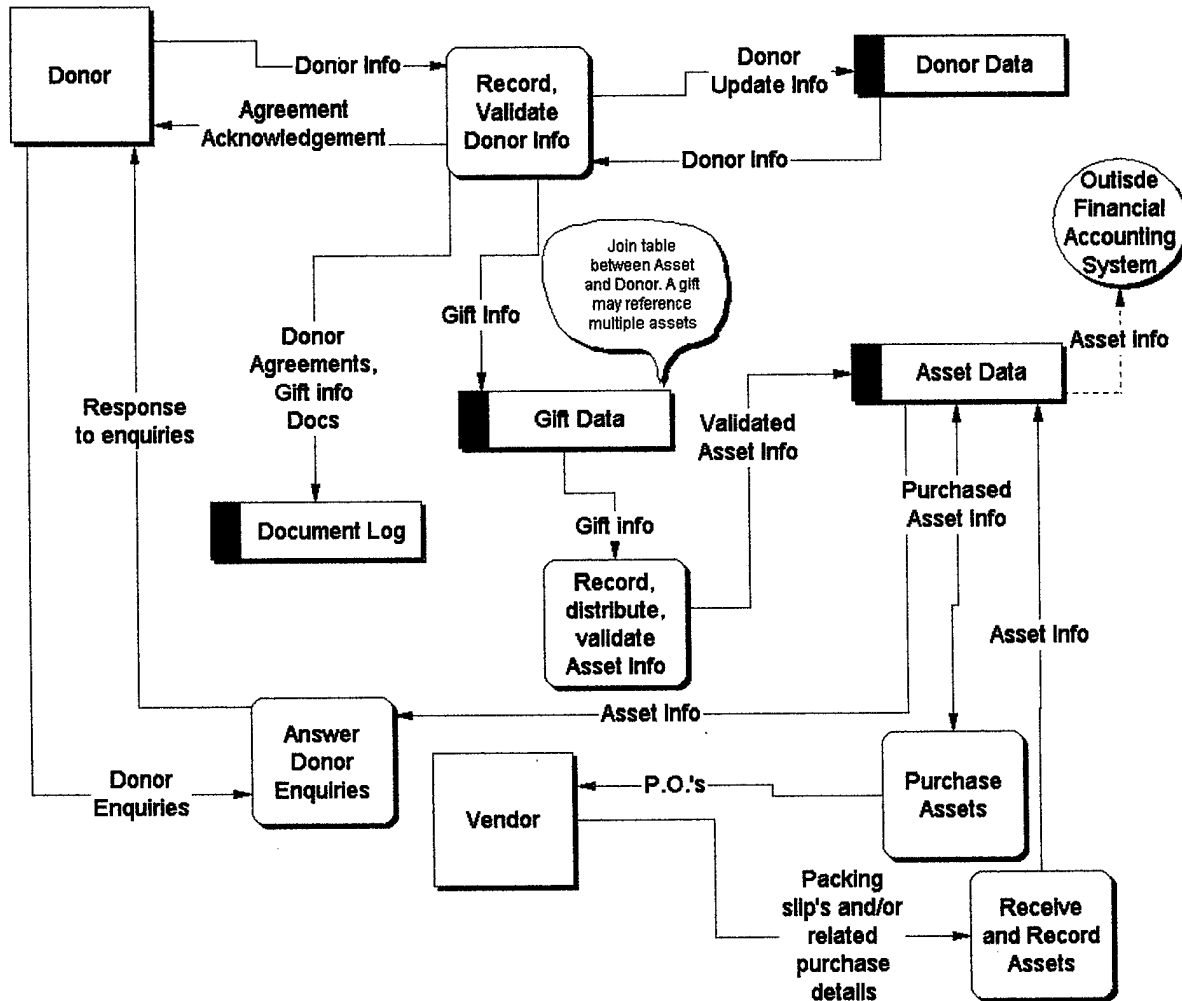
Diagram 2: The Asset Acquisition Process

Asset Acquisition

BP -1)   Assets may be acquired in one of two ways: by donation or by procurement. Sub-processes support donor and gift management for donated assets and interfaces with the procurement process through the contracted financial accounting system. The donor management side of the process supports the databases maintaining donor, pledge, and gift information. Data will be replicated from the Financial Accounting System sufficient to support the management of procured assets within the Asset Management System.
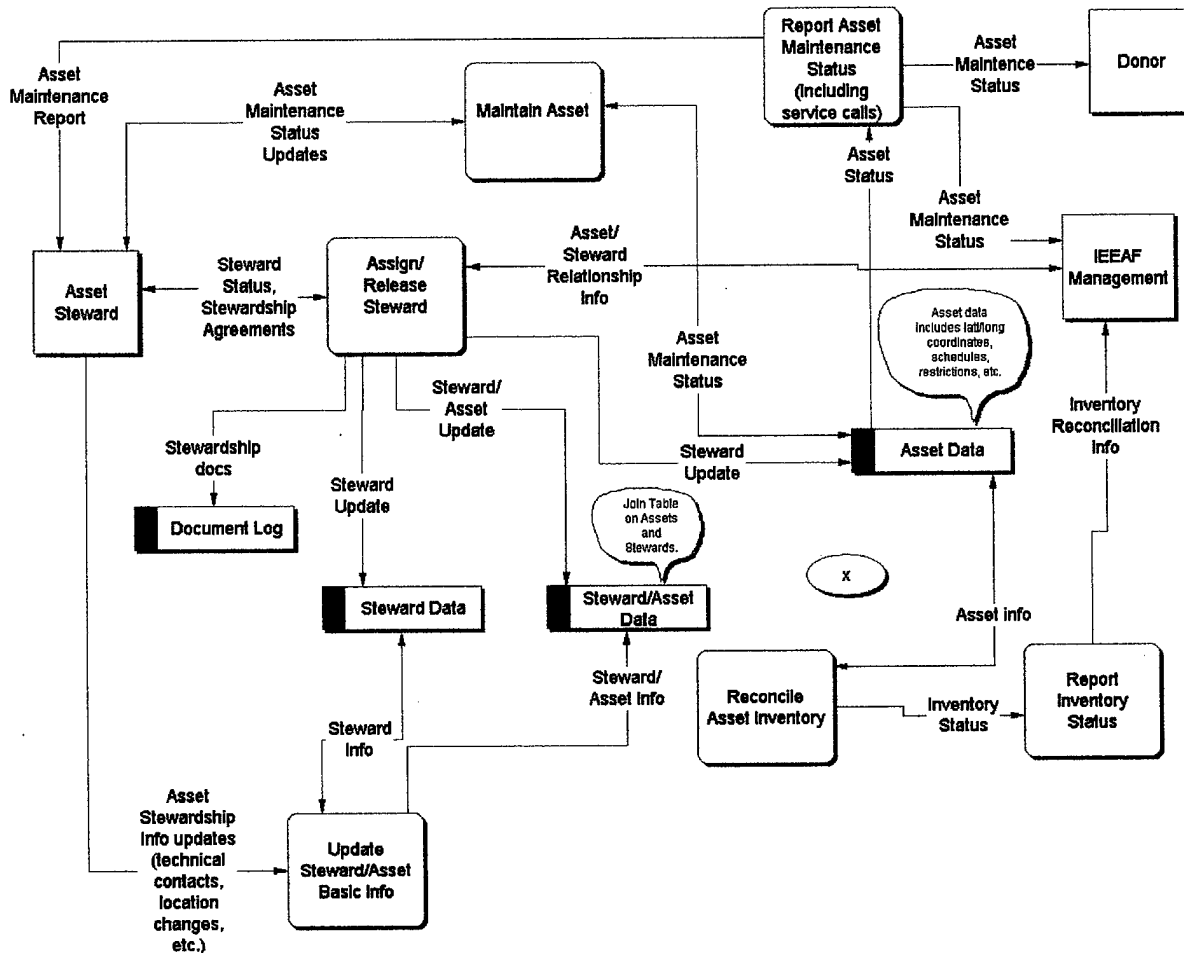
Diagram 3: The Steward Assignment and Inventory Reconciliation Process

Asset Inventory and Accountability, Asset Maintenance, and Stewardship Assignment

BP - 3) Maintains the attributes of the assets including but not limited to physical, geographic, topology (connections to other assets forming networks), bill of material (drill down on components, e.g. racks within carrier hotel space, slots within racks, components on rack, boards in component, etc.), scheduling parameters, financial costs and income, operational status, support contacts, and restrictions and limitations placed on the use of the asset. It also supports periodic physical inventories and reconciliation.

BP - 4) Supports the information relevant for repair and maintenance of each asset including agreements and their timely renegotiation, service work orders placed including changes in location, and maintenance history of the asset.

BP - 6) Supports the assignment of a steward geographically close to the asset for local management and maintenance of the asset. Databases manage the stewardship agreement, asset-to-steward assignments, and steward contact information.
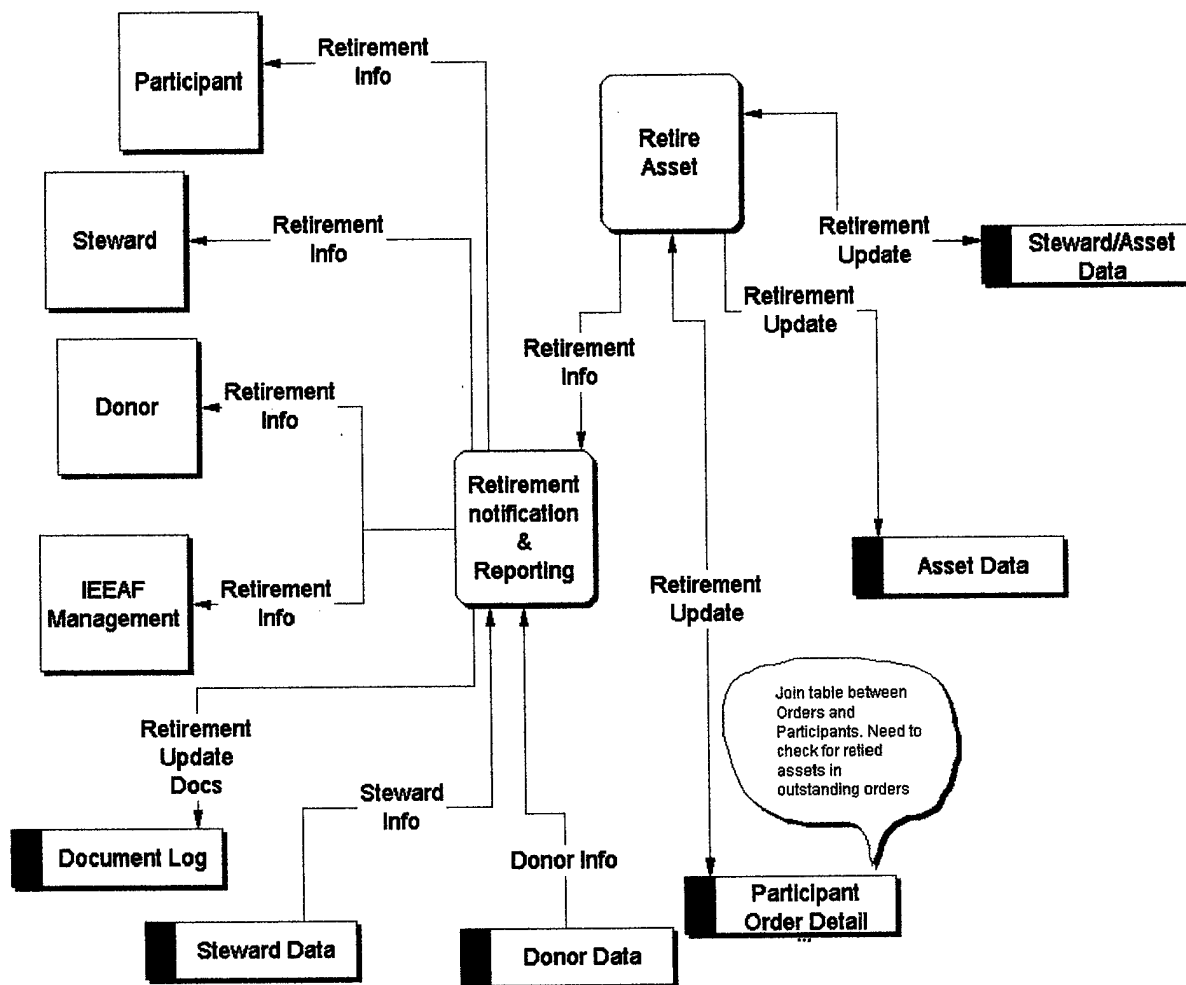
Diagram 4: The Asset Retirement Process

Asset Retirement

BP – 5) Supports the permanent removal of an asset from service due to contractual expiration or problematic maintenance history and disposal. Process must consider current customers of the asset and their support during transition.

Some assets may be
subdivided and asset
data may have to
contain parent/child
relationships

**Participant
Order Data**

Asset Data

Order
Update

Steward Data

Order Info

Asset Info

Steward
Data

**Configuration
Data**

**Steward/Asset
Data**

Steward/
Asset Data

**Configure
Asset**

Config data

**Network
Operations
Center
(NOC)**

Configuration
Info

Configuration
& Scheduling
Info

Contains
invoice
contents

**Participant
Order Detail**
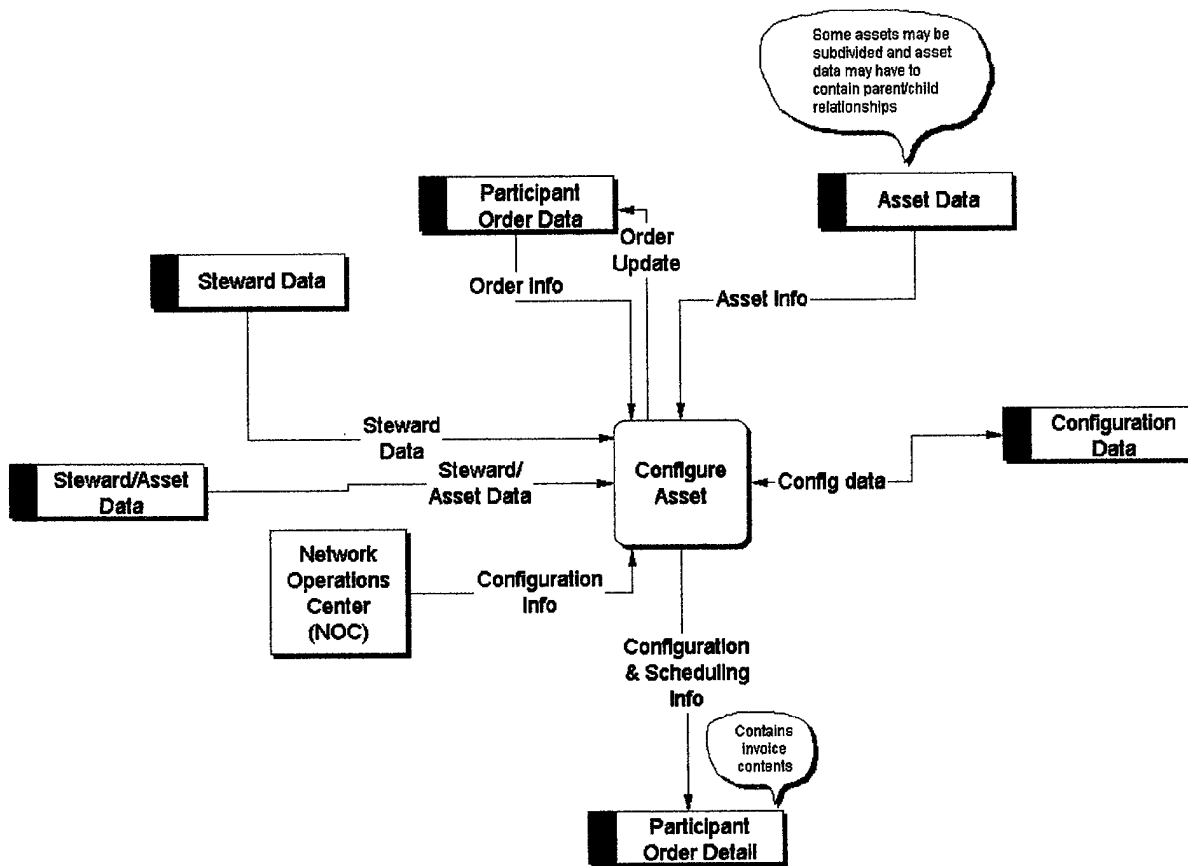
Diagram 5: The Asset Configuration Process

Asset Configuration

BP-9) This process may be required or not depending on the status and configurations of the existing asset base. It may be the responsibility of the customer or of the IEEAF depending on the specific asset(s) required and the current configuration. This process may establish new or changed relationships and connectivity among multiple assets to complete the specific requirements of the "customer". The process must take into consideration the current utilization of partially requisitioned assets by other customers.

Participant Order

Participant (affiliated/ non-affiliated)

Order Response

Order Docs — Document Log

Capture and validate Participant Order

Participant Info

Participant Data

Update & service Response

Order Cancellations, updates, enquiries info

Asset Info

Asset Data

Validated Participant Orders

Includes Config & Scheduling requests

Participant Info

Primarily Participant Billing

Outside Financial Accounting System

Service Request

Order Update Info

Asset Info

Process Order Cancellations, Updates & enquiries

Order Update Info

Participant Order Data

Order Info

Accounting interface info

Service Status

Includes Actual Config & Scheduling Details

Update info

Fill Order

Participant notification

Participant (repeated)

Participant Order Detail

— Order Info —

Order info

Process Service Request

Service Ticket

Service Request Data

Internal and external NOC participation in configuration and order processing

Report Orders

Order info

IEEAF Management

Configuration info

Network Operations Center (NOC)

Diagram 6: The Asset Order Management Process

Asset Order, Asset Scheduling/"Order" Filling, Service Order Assurance and Business Continuity, and "Order" Changes/Cancellation/Completion

BP – 8) Capture the requirements of a "customer" for one or more bandwidth assets and the quantity of each. The unit of measure for each asset may fall anywhere within the drill down levels of the "bill of material" or the topology of a completed network (i.e. links between multiple sites), Information is solicited on academic purpose for utilization of the asset, primarily for reporting on "highest and best use".

BP – 10) Determines the availability of the asset(s) for the term specified and schedules it. Cost recovery payments and schedules are established and participant (or Service Level) agreements maintained including failure consequences.

BP – 11) Provides customer service and cost recovery billing during the period of the agreement. This may include network operations, network monitoring and management, and problem reporting and resolution. Typical operational areas supporting the business process include a Network Operations Center and Help Desk. Billings must be compiled for all assets currently utilized by each customer and consider whether the participant is affiliated or non-affiliated.

BP – 12) Process again must consider total utilization of the asset(s) by this customer and others to execute changes requests in configuration, lifetime of the asset for contract extensions, etc. Cancellations and completions of service place the asset(s) or portions thereof back into inventory for requisition by other customers.
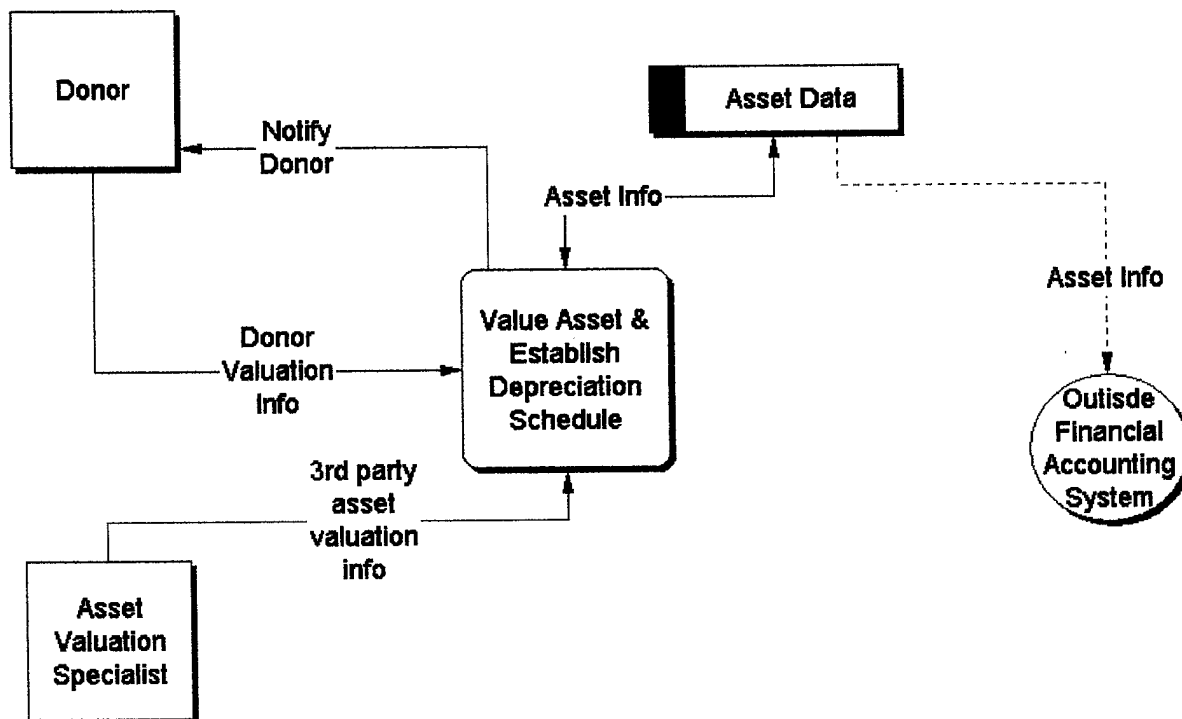
Diagram 7: The Asset Valuation Process

Asset Valuation

BP – 2) Establishes and maintains over time the value of the asset, lifetime, and depreciation schedule. Data must be sufficient to support annual financial statements, life cycle management of the asset, and other required reporting.
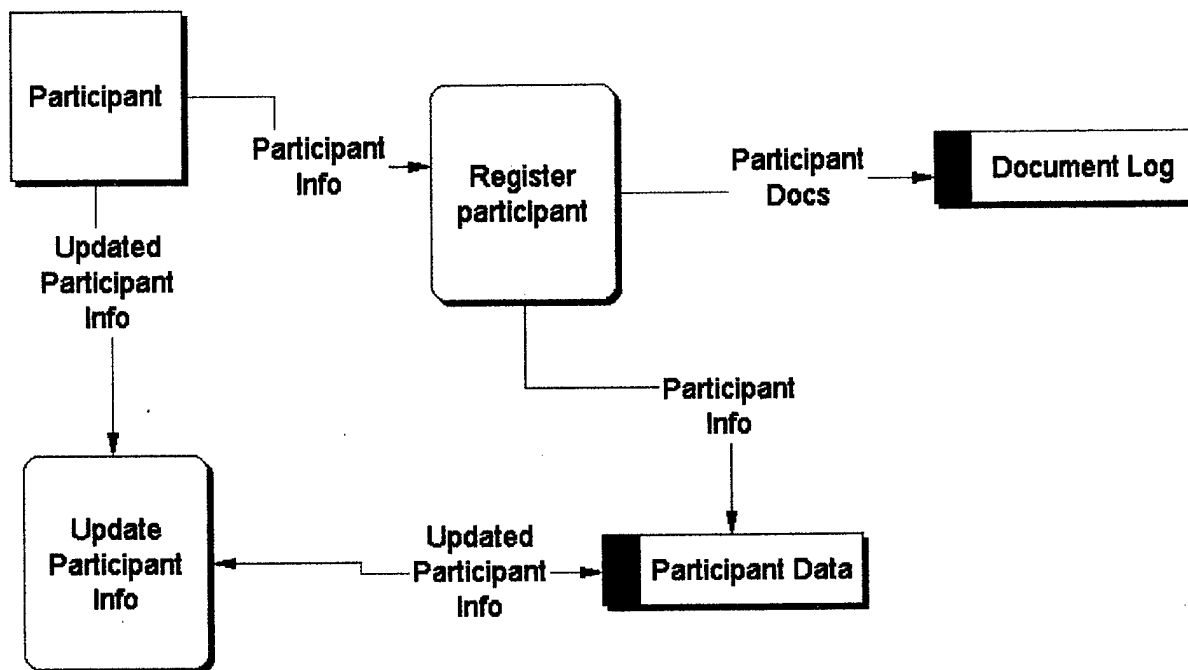
Diagram 8: Participant Registration and Maintenance

Participant Registration and Maintenance

BP 7) Captures and maintains the "customer" information for both "Participant Affiliates" and "Non-Affiliated Participants" including administrative, technical and financial contacts. Customer uses of the asset(s) are maintained and an accounts receivable interface with financial accounting system provider.

Reporting and Archiving (These processes are integrated with each of the others and not diagramed.)

BP –13) Compilations of data to support financial and government agency reporting, "highest and best use" of asset use for both internal assessment and to encourage future donor support, performance assessment, customer satisfaction, etc. License compliance tracking and audit mitigation between customer and the IEEAF and the IEEAF and donors reporting capabilities should be considered a part of annual reporting.

BP – 14) Removing records from active database and storing for audit purposes.

Data Analysis

Primary data groups in the AMS consist of the following:

- Donor
    - o Identification and location information
    - o Contacts (multiple contacts are possible)
    - o Gifts made

- Gift
    - o Description
    - o Type (ex. IRU, license, etc)
    - o Restrictions
    - o Initial value
    - o Location of documents

- Vendor
    - o Basic vendor information
    - o Contacts (multiple contacts are possible)
    - o Performance tracking information
    - o Transaction documentation identifier (a means of identifying documentation related to a particular transaction... invoice, payment, etc)

- Procurement
    - o Order Specifications
    - o Date and Status
    - o Amount
    - o Payment history

- Stewards
    - o Basic identification and location information
    - o Contacts
    - o Stewardship agreements
    - o Asset assignments

- Affiliates
    - o Basic identification and location information
    - o Contacts
    - o Scheduled or contracted assets
    - o Asset usage details
    - o Affiliate type (coded)
    - o Payment history

- Assets
    - o Asset description (includes serial number, physical characteristics, etc; see attachment B.)
    - o Asset type
    - o Geographic location (latt/long, etc.)
    - o Operating costs
    - o Restrictions and conditions of use
    - o Physical and logical configurations
    - o Value and life expectancy
    - o Related Contracts and other documents
    - o Warranties, service contracts,
    - o Licenses, IRU's
    - o Maintenance history
    - o Scheduling

- Configuration data
  - o Configuration task information (requestor, proposed assets, schedule, employee assignment, etc)
  - o Configuration task status
  - o Configuration profile (a record of events stored for later use so that the configuration can be automatically generated and a guide to creating similar configurations)
  - o Self discovery results information
  - o External configurable assets (a record of known outside assets that can be used in a configuration)
  - o Configuration test results
  - o Transaction record for asset creation (a configuration is an asset consisting of other assets; configurations are temporary)
  - o Configuration asset status (active, standby, removed, etc)

- Documents
  - o Basic document info (locator number, type, date, signature present, legal review, physical location, amendments, attachments, etc.)
  - o Party information (signatories, contacts, etc.)

- Maps and asset visual information
  - o Essential digital map information (source, location, last updated, format, etc.)
  - o Asset image information (source, location, last updated, format, connections to other visual objects, etc.)

Evaluation of Commercial Software Products

A number of asset management software products were reviewed and some best practices were identified. The following is a list of companies and some comments-

Peregrine Software

Peregrine is a rapidly growing San Diego based company that has a wide variety of application products in the areas of infrastructure, employee relationship, and business relationship management. Of particular interest to this project was a new product, called Xanadu. Peregrine recently acquired Remedy Software.

MainControl

MainControl's "i.series" product is primarily a help desk facility that contains a "self service" function that allows users to enter and track service requests. The company's other product, MC/Empower, manages asset life cycles from acquisition to retirement.

Adventnet

AdventNet's Management Builder is a Java/XML/CORBA based environment used to provide custom asset management functionality. The product uses Java Beans to provide interoperability with databases, mail servers, wireless devices, and network management.

Mycroft Systems

Mycroft systems is an Australian company whose Aperture Visual Information Manager provides a visual drill down interface for managing various asset classes.

Auto-trol Corp.

Konfig software is a product of Denver based Auto-trol Corporation. The product provides a wide range of capabilities including extensive financial control functionality, lease handling, and interface with OpenView and Oracle.

An investigation of software packages revealed that no one package has the unique capabilities required to support the full functionality needed in the asset management environment that we've envisaged. The ultimate AMS will contain a mix of inventory control, financial reporting and control, help desk, and network operating center. Xanadu from Peregrine Systems contained the broadest array of components and represented the closest fit yet it did not have the total capabilities required for the AMS. Although the use of off-the-shelf software is highly desirable, the most successful development scenario is the integration of "Best of Breed" products using a common front end (such as a web portal) along with "glue code" for underlying implementation. This concept is discussed in later portions of this report.

Site Visits and Interviews

As part of an information gathering effort, the AMS project team conducted site visits and interviews that were relevant to network operations or potential research opportunities:

- Indiana University, Telecommunications Division and Abilene Network Operations Center
Subject: Network Operations and Support (Brian Voss, Associate Vice-President of Telecommunications Division)

- Collaborative Agent Design Research Center (CADRC) at Cal Poly and CDM Technologies Corporation
Subject: Collaborative Multi-Agent Technology (Jens Pohl)

- Lockheed-Martin Corporation Network Operations Group in Santa Maria, California
Subject: Network Management (Gregory Vaughan, etal)

- Internet Educational Equal Access Foundation (IEEAF)
Subject: IEEAF Business Model (Jerry Hanley, Treasurer and Asset Manager of the IEEAF)

- Cal Poly, Information Technology Services
Subjects: Help Desk & Telecommunications Operations (Lygia Smidt, Information Technology Consultant, James Field and Ed Bruns, Network Analysts)

- Georgia Tech
Subject: Geographic Information Systems (Dr. Steven French, Director, Georgia Tech Center for Geographic Information Systems)

- Internet2
Subject: Arena Pathfinder Project

- GEOgraphic Network Affiliates-International, Inc.
Subject: TradeBandwidth, Contracting and Scheduling Bandwidth Assets through the Internet

Detailed trip reports for Indiana University and CADRC can be found in Attachment D.

The site visits helped clarify the problems in telecommunications asset management. In all cases, the asset management systems were not globally scalable, did not use new and emerging technologies, and exhibited poor systems integration. The systems were highly focused and continued to rely on extensive manual processing.

It should be noted that the technologies examined in some of the site visits, namely the CADRC (software agents and ontologies), Georgia Tech (advanced GIS applications in NOC management), and GEO Corp. (web-based trading of bandwidth) were of a research nature. The ramifications of these technologies for asset management are discussed in greater detail in the Research Park Center of Excellence section of this report.

Best Practice Analysis

The following list of "best practices" is based on a composite of features discovered in third-party software (above), web based research, and in consultation with the ITS staff at Cal Poly, Indiana University, Georgia Tech, TradeBandwidth Inc., and Lockheed-Martin Corporation.

- **User Interface**

  o **Web enabled**

  The software should be available as a web application usable in either IE or Netscape (or preferably both). The system should provide each user class (donor, participant, steward, management) with an appropriate and secure view of relevant information. Since web users may reside outside the U.S. provision should be made for language, time, and currency differences. The system should be accessible 24/7 from anywhere in the world. Security measures including a firewall should be enabled on the host server.

  o **Secure Web interface for customers**

  The system should contain a secure means of authenticating web users and provide the ability of users to change their passwords or (with the appropriate secure process) to handle forgotten passwords and ID's.

  o **Visual/graphical interfaces**

  A graphical front end for network failure, performance, and configuration monitoring. The graphical front end should include a drill down capability from a macro, map view to a component level view.

- **Business Process Support**

  o **Workflow**

  Software to receive, schedule, route, delegate, and manage employee service, equipment, status, and move requests.

  o **Handles depreciation, leases, and taxes**

  The system should be capable of depreciating assets, managing lease agreements, and tax reporting.

  o **Life cycle management**

  The acquisition, management, replacement, and retirement of assets should be part of the application.

  o **Schedule management**

  This includes the ability to schedule asset acquisition, use, retirement, valuation, control (stewardship), service, and maintenance.

o **Physical inventory reconciliation**

A periodic physical inventory should be supported in the application.

o **Integration with F/A, A/P, and ERP systems**

The system should be capable of either a data exchange with an outside financial accounting system including procurement, accounts payable, and accounts receivable (such as the Cal Poly Foundation) or at the least, a view into a these systems. Thus, some components of an outside accounting system might be used to support internal accounting for the system. Invoice reconciliation and other functions should be supported.

o **Supplier and procurement management**

The system should handle non-donation acquisitions from suppliers. This includes purchase order production, supplier contact information, receiving, returns, reporting, and the standard set of purchasing functions.

o **Integrated service management**

The software should be capable of managing the creation, tracking, and closing service requests for all assets.

o **Outside asset management**

The system should be capable of interfacing with other systems or manually capturing relevant information. Thus, connectivity configuration can include assets outside the system.

- **Data Management**

  o **Database Integration**

  Hooks into popular DB products such as Oracle, SQL Server and DB2

  o **Disaster recovery integration**

  The system should support full local and remote backup and recovery with integrated scheduling.

- **Network Management**

  o **Network asset discovery (auto discovery)**

  The software should be capable of discovering and registering network components on the fly. Relevant data attributes should be captured during the auto discovery process and supplemented by users. Geographic coordinates (latitude/longitude) should be included in the discovery and registration process.

  o **Configuration and change management**

  Includes the ability to manage network, software, and hardware configurations and versions.

  o **Service desk consolidation**

  The system should provide facilities for a centralization of help desk operations such that service requests all flow through the system. Thus, service can be dispatched to other geographic locations via connection to local help desk or service facilities. For example, a connectivity

problem for a user in the U.S. might be the result of a failure in a component in the Netherlands. The system should be capable of dispatching service in the Netherlands.

- **Document and Contract Management**

  o **License compliance tracking & audit mitigation**

    The system should capture all license information and track license usage and expiration.

  o **Contract and lease management**

    This feature includes indicators for lease renewal, change notices

  o **Warranty, maintenance management**

    The management of contracts, payments, and alerts for both maintenance and warranty should be part of the system

- **Deployment**

  o **Scalable and flexible for deployment or resale as an asset in itself**

    Ideally, the AMS would be sufficiently scalable within the narrowly focused application of not-for-profit telecommunications asset management such that it could be packaged for use by other similar organizations, private corporations, and public agencies.

Prototype Development

The prototype application was developed to serve two purposes:

1. Gain a deeper understanding of the issues and complexities of designing, developing, implementing, and maintaining the data and processes associated with managing assets in a complex environment and
2. Provide a proof of concept application (for the IEEAF) to record and track early asset donations, donor, gifts, stewards, and participants.

Prototype development was useful in determining data flow, understanding the issues associated with managing the data, and reinforced the recognition of the need to provide a web interface in the application. It was also useful in testing the capture of essential donor, steward, asset, and affiliate information as well as the formulation of a valid data model. A good data model is deemed essential for future development success. The prototype helped reveal the complexity of data relationships for this application.

Overview of System Architecture

The proposed systems architecture for the Asset Management System (AMS) consists of five levels of increasingly complex functionality. Each version builds on functionality found in prior levels. Diagram 1 illustrates a view of the asset management problem that consists of a core set of functions to capture and manage essential asset, donor, steward, and participant data. The second level system builds on the capabilities of this core system and adds enhanced functionality consisting of asset valuation, retirement, depreciation, and maintenance. The third level version is characterized by connections to external financial system(s) primarily consisting of a general ledger, purchasing, and tax reporting. The fourth level version contains functionality that enables the visualization and location mapping of assets. The fifth and final version of the system consists of full network operating system functionality characterized by network asset self-discovery, fault and performance monitoring, a help desk, and connectivity management.

Versions 1 and 2 are designed to meet internal requirements and focus on simple asset tracking and reporting with no connection to outside systems. Versions 3 and 4 extend the application to external sources and provide a foundation for version 5, a full network-operating center.

The architecture implies a high degree of component integration. Given time and funding constraints, it is assumed that many of the components will consist of 'best of breed' commercial off-the-shelf (COTS) products with custom "glue code' created to provide the integration rather than a costly custom system development effort. It is assumed that a custom effort in this area would be "reinventing the wheel". In particular, the relatively sophisticated components required in versions 4 and 5 are likely to consist of commercial visualization and network management products. Ideally, these products should have an application program interface (API) that simplifies the integration process. The products are discussed in greater detail in the relevant sections.

Although no specific recommendation is made concerning development environments, computer languages, and hardware, sufficient tools and COTS products are available in the two primary operating system platforms, namely UNIX and Microsoft Windows. Both of these operating environments run on Intel hardware platforms and Intel would likely be the platform of choice. In addition, no specification is made for the back end database environment. However, since most COTS products use either Oracle or SQL Server, it's likely that either (or perhaps both) would be used.

Given a highly heterogeneous hardware and software mix as well as the need for interconnection with other network-based systems, the use of XML as an interoperability solution is part of the proposed architecture.

Manage
 ^ าor/Steward/Participant
    counts
Basic asset tracking functionality
Basic reporting/queries

Depreciation,
maintenance,
retirement,
valuation, warranty
& document
management

**Version 1
Core
Functionality**

**Version 2
Enhanced
Functionality**

**Version 3- External
Interface & asset ordering**

Version 4
Advanced Human
Interface

Version 5
Network Operating
Center

Connection to
outside
financial
systems & fixed
asset ordering

Asset visualization,
location, and mapping

Network management including
auto-discovery and monitoring
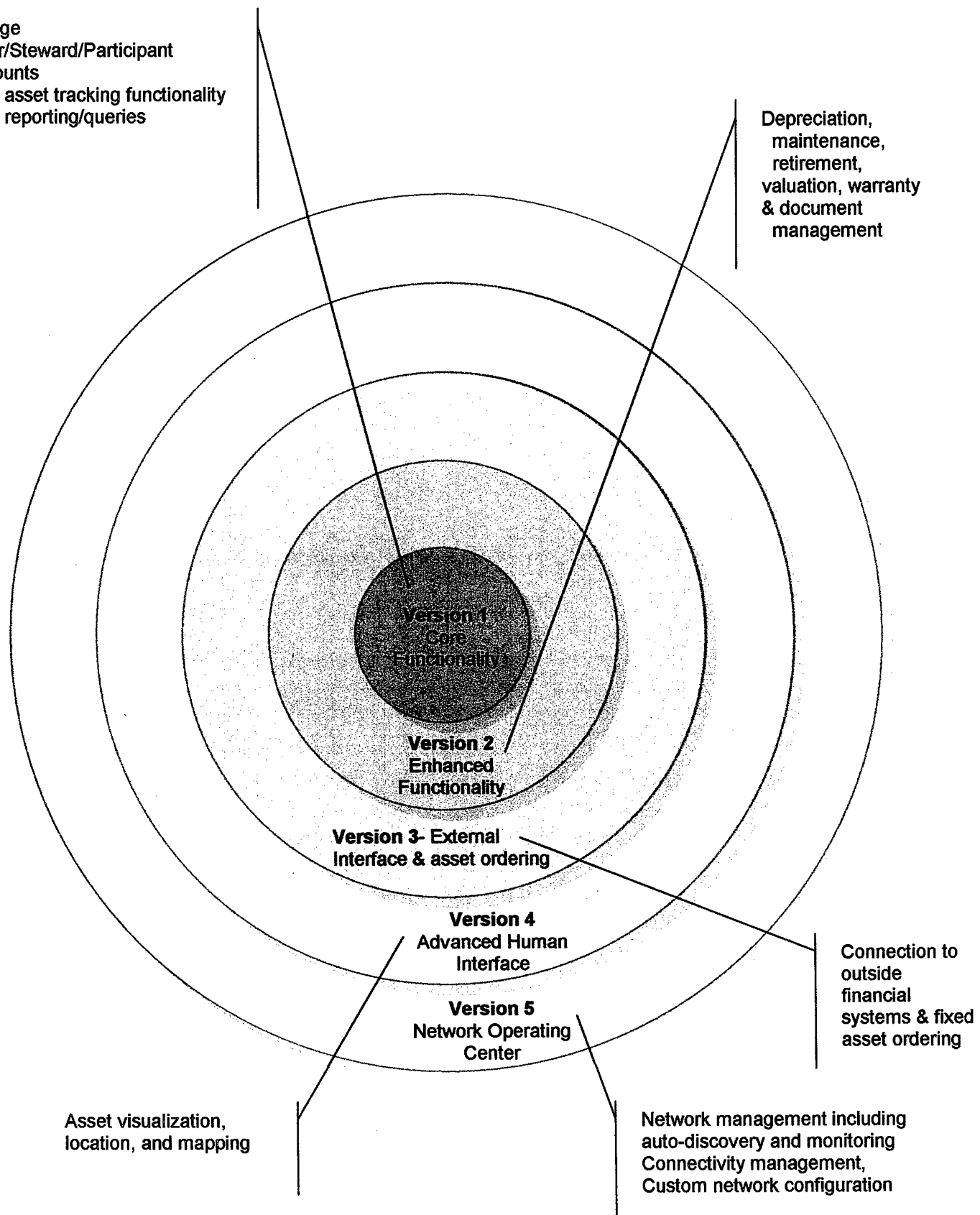Connectivity management,
Custom network configuration

Diagram 9: Five Levels of Functionality for the Asset Management System

Key Issues in the Architecture

Underlying the proposed asset tracking solution is a set of key issues that surfaced as the team researched the problem. They are –

- **Asset Indeterminacy**

    Although many assets fall within standard categories (dark fiber, carrier hotel space, bandwidth, etc), some asset donations cannot be classified in advance. However, version 5 of the system (network operating center) will require that detailed data on assets be available for maintenance, monitoring, and configuration. Thus, an end-user process for creating new asset classes is required. In a relational DBMS this will mean the creation of a new table. In addition, new classes must be incorporated into the existing data model such that referential integrity and foreign key relationships are properly maintained.

    A potential solution would be the creation of a screen form consisting of a simple set of text fields, check boxes, and pull down menus that allow end users to create a new asset table. Submission of the form would result in a request to insert an entry into a master asset table. The entry into the table would trigger a set of SQL statements that would create an asset table where the asset data from each new asset of this class would reside. Also, the SQL statements would call a script that would cause the generation of related maintenance forms and entries into the appropriate menu structure. In addition, referential integrity constraints would be enabled based on the foreign key relationships that were formed. An entry would be created in a "Master Asset Classification Table" (Diagram 10) that contains a reference to all of the asset tables. The table would be used to enforce consistency and integrity in menus and reports. The asset class identifier would be a foreign key in each asset table along with donor or vendor, steward, and participant foreign keys. In short, new asset classes would be added to the table and the table would be used to create the associated forms and reports needed to manage the new asset class.
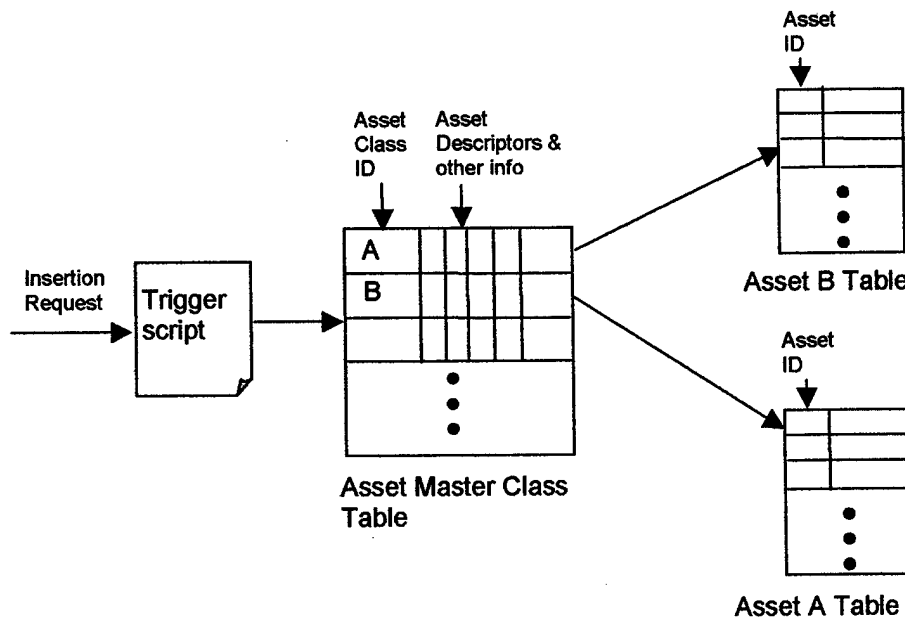

Diagram 10
A Master Asset Table Approach to Solve the Problem of Asset Indeterminacy

- **Multiple Database Environments**

  Many COTS applications are based on the use of either proprietary database environments (sometimes embedded) or a DBMS from a particular vendor. It's likely that the use of multiple COTS applications might require that custom code be written to integrate data from multiple databases for versions 4 and 5 of the system. Thus, a distributed database approach should be considered. The degree of database separation and complexity will be apparent as versions 3, 4, and 5 are developed. The ability to connect to a variety of DBMS's would be a consideration in the selection of any COTS product. A single database solution across all versions of the architecture is ideal although probably not feasible. The use of XML as a database intermediary technique needs to be further explored in the architecture.

- **Complex Asset Interrelationships**

  Some assets contain other assets and this must be represented in the data model of the application. For example, a carrier hotel space (an asset by itself) might contain other donated assets (such as a switch). In turn, the switch might be connected to other fiber assets and this connection needs to be represented. A relatively simple technique involving the use of parent, child, and link fields could be employed to represent these relationships.

- **Database Structure**

  The following is a discussion of some alternative techniques for representing and storing data in the AMS

  The implementation of version 1 of the system will have a standard fixed data structure as indicated below. However, several alternative data approaches are included for future reference.

  o **Fixed Data Structure (the current implementation)**

    All attributes and associated forms are fixed by the developer.

    Pros:
    Standard database approach easily developed and implemented. Detailed data capture and reporting. A highly granular structure may be required to support functionality found at higher levels.

    Cons:
    Inflexible. Difficult to maintain when assets change or new types of assets are added.

  o **Mixed Data Structure (potential future implementation)**

    Core asset attributes are fixed but an indexed memo field is used to include new attributes. Thus, an asset can be categorized by its core attributes but additional attributes can be added to the memo field "on the fly". Or, the memo field might contain a large text description of the asset that represents an alternative view. The fixed portion of the data structure might be used to enable recursive "Bill of Material" relationships. For example, carrier hotel space might contain other assets (ex. a UPS) and this connection could be maintained via parent/child attributes. Thus, assets could be contained in a hierarchical structure. A mixed data structure might be implemented in other ways including the development of specialized descriptor table structures that support the ad hoc creation and change of other tables.

    Pros:
    Provides a flexible method of capturing asset data while retaining categorization and "Bill of Material" capabilities. Provides both an asset attribute and text view of data.

    Cons:
    Difficult to develop.

o **Text oriented, search engine-based data structure (potential future implementation)**

Most asset attributes, including many core attributes, are captured and represented in the form of text descriptions. However, unique identifiers (e.g. serial numbers), foreign keys, keywords, "contained in" attributes and other static information are contained in fixed attributes. Data that is likely to be variable are represented as text. An index engine is used to categorize asset attributes and users can search the database by ID, category, keyword or any word contained in the text description. XML could be used as the underlying representation scheme. This could be characterized as the "EBay" approach.

Pros:
Fairly easy to develop and implement. Solves the asset indeterminacy problem since text field information can be easily modified and re-indexed. Any type of asset can be handled in the future. Users receive full text descriptions of the assets as web pages. Complex assets and *related documentation* can be represented, searched and viewed.

Cons:
Offloads much of the categorization process to the user in the form of the search process. Participants must understand their needs and be able to form a proper search. The details contained in standard reports will be primarily limited to the data contained in the fixed fields. Complex queries may be required for certain reports. May not support future functionality (e.g. asset configuration)

o **XML Based Approach (potential future implementation)**

The capture of data using XML as the underlying representation scheme offers the potential for solving the problem of asset indeterminacy as well as the need to transfer data between disparate applications. New XML descriptor tags could be generated for new attributes when needed without affecting existing applications. Also, data encapsulated in XML can be read and altered via web pages that sense the changes in the data and provide additional data entry fields to correspond to the new attributes. Thus, the user interface dynamically adjusts itself to the underlying data. In addition, application interoperability is greatly enhanced with the use of XML since it is platform, vendor and media neutral. An XML-based telecommunications asset description language is likely to emerge in the future and the transformation of existing data into this format would be easier. As well, data on new assets could be acquired more easily if it's in an XML format.

Pros:
Solves the problem of asset indeterminacy and allows for easier application interoperability. XML pages can directly read by end users. Name brand database systems have XML translators that allow the data to be stored efficiently. Queries easily developed. Parent/Child relationships can be implemented in XML and d*ocuments and other objects can be represented in XML.*

Cons:
New technology with inherent risks. Difficult to find developers with sufficient expertise. Standards still developing.

Regardless of the overall approach employed in this version, the following capabilities are essential-

1. Flexible and seamless ability to add new asset classes
2. A representation of parent/child relationships that may exist for some assets (i.e., some assets are contained in other assets)
3. A method to tie documents to assets, donors, stewards and participants.

Detailed System Architecture

Version 1 – Core Functionality

This version contains an essential set of processes and data that are the foundation for later versions. It is characterized by a set of asset tracking processes and a supporting data model that allow the capture and management of assets, donors, stewards, and participant information. Diagram 1 (Page 11) is a top-level view of the stakeholders and their respective information flows into the AMS.

Highlights

- Donor, gift, steward, and participant information is captured via a set of standard forms
- Detailed asset data is captured for five specific asset types
- The Stewardship Assignment, Asset Valuation, and Asset Maintenance business processes are supported
- Process and data details are described in Section 2 of this report.

Forms and Functionality

- **Manage Donors, Gifts, Stewards, and Participants**

    A set of forms used to capture and manage information on donors, gifts, stewards, and participants. Specific information and processes supported include:

    o Maintenance of the donor attributes and an unlimited number of contacts within the donor organization necessary to complete the legal, administrative, and technical acceptance of a gift (Based on the IEEAF Asset Donation Form, Schedule D-1).
    o Maintenance of an unlimited number of donors "pledged" gifts including type of gift, value, gift restrictions, and location of documents related to the gift.
    o Maintenance of the steward and an unlimited number of steward contacts, stewardship agreements, and asset assignments.
    o Maintenance of participants (both Affiliates and non-affiliated or commercial participants) and an unlimited number of contacts for each. (*NOTE: there is no support for a participant to schedule or contract for the use of the assets in the prototype.*)
    o *Included are forms for the maintenance of vendors and procurements (the second way in which an asset can be acquired). These are not active in the prototype delivery.*

- **Manage Assets**

    A set of electronic forms used to capture and manage asset information based on a set of asset attributes defined in a group of Asset Forms (see Attachment C of Section 2 of this report). Specific information and processes supported include:

    o Maintenance of the asset and its attributes as described below. Upon initial entry, the asset is associated with the specific donor-gift that has resulted in receipt of the asset (*NOTE: provision has been made to substitute the vendor-procurement association in future versions.*)
    o Maintenance of the geographic location of the asset including longitude and latitude for future GIS display. (In the case of bandwidth, fiber, etc. the head-end location is defined with segment locations to follow in the detail.)
    o Maintenance of the current and historical values placed on the asset. (All valuation is done externally to the prototype and entered only.) Entries must be recorded as a log with date and value in a text field in the prototype. Provision is made for entry of supporting documentation information.
    o Maintenance of asset restrictions. Only one entry is allowed but the text fields allow for the potential of multiple terms and conditions of use. Again, notations can be made on supporting documentation.

- o Maintenance of an unlimited number of asset contacts.
- o Maintenance of an unlimited number of asset service/warranty agreements. Specific maintenance activities can be tracked for each agreement; in the prototype history must be maintained as a log by date and service activity in a text field.
- o Maintenance of the specific physical specifications, associated costs, conditions of use, and related document information (such as location) for the asset (see Attachment C in Section 2). In the prototype, five specific assets have been defined (these are expected to expand over time). These five are:
  - Carrier Hotel (or Accommodations)
  - Managed Bandwidth
  - Dark Fiber
  - Wavelengths
  - Equipment

  Some assets have repeating attributes within them and the prototype provides for only six until it is determined that this level of detail is warranted. It does not directly address the issue of a "bill of material" or simple parent-child relationship at this time. Fields labeled "Comment" or "Other" may be used to indicated the parent asset (e.g. a carrier hotel may be the parent for a rack, a rack for a piece of equipment, etc.)

Reporting and Queries

No default reports or queries are delivered with the prototype. The System Administrator can develop to meet requirements as they become known using Access directly against the database.

Archiving

No provision has been made for archiving of information in the prototype.

Technical Environment

- Windows based microcomputer with approximately 20mg bytes of space and Windows 95 or later version
- The prototype application is written in Visual Basic 6 with data stored in an Access 97 database. It is designed for implementation on a single workstation.
- The security features of Visual Basic and Access have not been included in the prototype.

Version 1 – Core Functionality Summary

	Business Processes			
1	Asset Acquisition	x		Donated Asset only
2	Asset Valuation	x		
3	Asset Inventory and Accountability	x		Limited number of types of assets
4	Asset Maintenance	.x		
5	Asset Retirement		x	
6	Stewardship Assignment	x		
7	Participant Registration and Maintenance	x		
8	Asset Order		x	
9	Network design and engineering		x	
10	Asset Scheduling/"Order" Filling		x	
11	Service Order Assurance and Business Continuity		x	
12	"Order" Changes/Cancellation/Completion		x	
13	Reporting	x		
14	Archiving		x	
	Best Practices			
	User Interface			
	• Secured web interface		x	
	• Web enabled forms and database maintenance		x	
	• Visual/graphic Interfaces		x	
	Business Process Support			
	• Workflow		x	
	• Depreciation/appreciation, leases, and taxes		x	
	• Asset life cycle management		x	
	• Asset schedule management		x	
	• Physical inventory support		x	
	• Integration with F/A, A/P, A/R, and ERP systems		x	
	• Supplier and procurement management		x	
	• Customer billing		x	
	• Integrated service management		x	
	Data Management			
	• Database integration	x		Access 97
	• Disaster recovery		x	
	• Standard reports and queries		x	
	Network Management			
	• Network asset auto discovery		x	
	• Configuration and change management		x	
	• Help (service) desk consolidation		x	
	Document and Contract Management			
	• License compliance tracking and audit mitigation		x	
	• Contract and lease management	x		Records location of document
	• Warranty, maintenance management	x		Records location of document
	• Building and floor plans		x	
	• Insurance policies		x	
	• Liens and lien waivers		x	
	• Physical and logical bandwidth topology		x	
	• Testing results		x	
	• Asset titles	x		Records location of document
	• Equipment and performance specifications		x	
	• Training requirements, schedules, restrictions, and costs		x	
	• Other contracts		x	

Version 2 – Enhanced Functionality

The next version of the application will focus on an expansion of functionality to handle more of the data structure, data access, querying and reporting that are inherent in telecommunications asset management. This version is characterized by a migration to a robust database such as Oracle or SQL Server, the inclusion of a data structure that supports "bill of material" processing, full web enablement as well as other functions listed below. In addition, it will allow for the creation of new asset classes.

Highlights

- **Functional Enhancements**

    o Asset retirement

    Asset retirement scheduling, notification, and documentation. Asset retirement includes the changing of the asset status from "active" to "retired", moving the asset record to an archive, and steward notification.

    o "Bill of material" or parent-child relationship support in the data structure

    Supports asset configuration via a data structure that allows for asset decomposition in the case where one asset contains or is linked to other assets (ex. a specific carrier hotel space).

    o Advanced query and reporting capability

    Supports ad hoc queries and reporting on all data tables.

    o Full web enablement

    Secure web access to all forms, queries, and reports with access control implemented via server and DBMS based policy. Users receive access based on their group membership. For example, affiliates only have access to affiliate related information and stewards only have access to steward related information. In addition, users within each group maintain their own user profiles.

    o Warranty and maintenance processing

    Allows for the capture of warranty and maintenance information, out-of-warranty notification, maintenance scheduling and status, and chargeback. Note: version 1 only stores document reference data and do no warranty processing.

    o Support for new asset class creation

    Allows for the unrestricted creation of new asset classes. New asset classes are automatically integrated into forms, queries, and reports. See "Key Issues in the Architecture" (above) for a detailed discussion of an approach to the implementation of this feature.

    o Workflow processing (task list and calendar only)

    In this version, workflow processing only consists of task list maintenance with an associated calendar for fixed asset ordering, warranty, and asset maintenance. Full workflow processing for custom asset order is available in version 5.

    o Physical inventory

    Generates physical count sheets and includes reconciliation forms and reports

- **Technical Enhancements**

  o   Robust database such as Oracle

  o   Data editing and masking

  o   Web interface for data entry and viewing

  o   Data security

  o   Data archiving

Version 2 – Enhanced Functionality Summary

	Business Processes			
1	Asset Acquisition	x		Donated Asset only
2	Asset Valuation	x		
3	Asset Inventory and Accountability	x		Limited number of types of assets
4	Asset Maintenance	x		
5	Asset Retirement	x		
6	Stewardship Assignment	x		
7	Participant Registration and Maintenance	x		
8	Asset Order	x		
9	Network design and engineering		x	
10	Asset Scheduling/"Order" Filling		x	
11	Service Order Assurance and Business Continuity		x	
12	"Order" Changes/Cancellation/Completion		x	
13	Reporting	x		
14	Archiving		x	
	Best Practices			
	User Interface			
	• Secured web interface	x		
	• Web enabled forms and database maintenance	x		
	• Visual/graphic Interfaces		x	Standard web interface without advanced features (Zoom, network map, etc.)
	Business Process Support			
	• Workflow	-		Task list and calendar only, complex workflow in version 5 (NOC)
	• Depreciation/appreciation, leases, and taxes	x	-	Some split functionality with external financial systems in version 3
	• Asset life cycle management	x		
	• Asset schedule management	x		
	• Physical inventory support	x		
	• Integration with F/A, A/P, A/R, and ERP systems		x	
	• Supplier and procurement management	-		
	• Customer billing		x	
	• Integrated service management		x	
	Data Management			
	• Database integration	x		
	• Disaster recovery	x		
	• Standard reports and queries	x		
	Network Management			
	• Network asset auto discovery		x	
	• Configuration and change management		x	
	• Help (service) desk consolidation		x	
	Document and Contract Management			
	• License compliance tracking and audit mitigation		x	
	• Contract and lease management		x	
	• Warranty, maintenance management	x		
	• Building and floor plans		x	
	• Insurance policies		x	
	• Liens and lien waivers		x	
	• Physical and logical bandwidth topology		x	
	• Testing results		x	
	• Asset titles	x		Records document location
	• Equipment and performance specifications		x	
	• Training requirements, schedules, restrictions, and costs		x	
	• Other contracts		x	

Version 3 – External Interface & Fixed Asset Order Processing

This version is characterized by integration with one or more outside systems including financial and help desk systems as well as the handling of affiliate orders for fixed assets. Fixed (discrete) assets are such items as point-to-point bandwidth, equipment, specific carrier hotel space, etc. These assets do not include custom connectivity creation reserved for version 5 (the full network operations center).

External financial system integration is likely required for tax reporting, third party billing, auditing, outside financial control, and access to specialized features found in outside software (such as a help desk system). Integration may take the form of direct integration via an application program interface (API), the creation of an intermediary batch file (for later processing by the outside system), or the development of composite presentation views (possibly via a web portal) that include elements of the asset management system and the external system (users work with both systems simultaneously). The web portal approach is of interest since the interface will have a consistent look and feel but contain direct or indirect connections to outside systems, In general, external systems are likely to be web enabled or are in the process of becoming web enabled. New web portal construction tools make the development of the human interface as well as the system interface easier. Clearly, XML is the ideal data representation scheme for data interchange with outside systems. In addition, consideration should be given to creating extranet or web service connections to outside applications.

Highlights

- Depreciation/appreciation, leases, and taxes

  Depreciation calculations and changes in valuations may be maintained within the AMS; however, values will have to be passed to an outside financial system. In addition, lease and tax information can be recorded locally in the AMS but would have to be passed to an outside financial system.

- Provides a transparent and seamless connection to outside financial systems

  Ideally, this process is implemented such that data flows directly from the AMS into the external system. XML or some XML based standard such as XBRL (eXtensible Business Reporting Language) or a tool such as BizTalk from Microsoft are possible solutions.

- Document management capability and integration

  Includes the ability to scan, store, retrieve relevant documents including such items as floor plans, contracts, licenses, titles, test results, insurance policies, etc.

- Vendor/procurement processing interface with outside systems

  The ability to transmit and receive vendor data, P.O., receiving, and related payment information from an outside financial system. Local copies of purchasing information will be retained but the primary objective of this function is to interface with an outside purchasing system.

- Passes donation-related transaction data to the appropriate accounts within the accounting structure of outside financial systems

  For tax reporting purposes, some data (such as asset valuation and depreciation) may be maintained externally.

- Handles IRS related reporting directly or through an outside financial system

- Handles reporting to other outside entities

- Help desk support for fixed asset usage

  Given the specialized nature of help desk support and the availability of off-the-shelf software, integration with an outside system is preferable to building this functionality into the AMS for fixed assets. Note that full network help desk functionality is required in version 5.

- Archive and log creation and maintenance and backup and recovery processing

  For system maintenance, backup, recovery and auditing purposes, transaction archives and logs are maintained.

Version 3 – External Interfaces Summary

	Business Processes			
1	Asset Acquisition	X		
2	Asset Valuation	X		
3	Asset Inventory and Accountability	X		Limited number of types of assets
4	Asset Maintenance	X		
5	Asset Retirement	X		
6	Stewardship Assignment	X		
7	Participant Registration and Maintenance	X		
8	Asset Order	-		Fixed assets only
9	Network design and engineering		X	
10	Asset Scheduling/"Order" Filling	-		Fixed assets only
11	Service Order Assurance and Business Continuity	-		Fixed assets only
12	"Order" Changes/Cancellation/Completion	-		Fixed assets only
13	Reporting	X		
14	Archiving	X		
	Best Practices			
	User Interface			
	• Secured web interface	X		
	• Web enabled forms and database maintenance	X		
	• Visual/graphic Interfaces		X	Basic web forms only
	Business Process Support			
	• Workflow	-		Task list and calendaring
	• Depreciation/appreciation, leases, and taxes	X		
	• Asset life cycle management	X		
	• Asset schedule management	X		
	• Physical inventory support	X		
	• Integration with F/A, A/P, A/R, and ERP systems	X		
	• Supplier and procurement management	X		
	• Customer billing	X		
	• Integrated service management	X		
	Data Management			
	• Database integration	X		Distributed DB environment
	• Disaster recovery	X		
	• Standard reports and queries	X		
	Network Management			
	• Network asset auto discovery		X	
	• Configuration and change management		X	
	• Help (service) desk consolidation	-		Fixed assets only
	Document and Contract Management			
	• License compliance tracking and audit mitigation	X		
	• Contract and lease management	X		
	• Warranty, maintenance management	X		
	• Building and floor plans	X		
	• Insurance policies	X		
	• Liens and lien waivers	X		
	• Physical and logical bandwidth topology		X	
	• Testing results	X		
	• Asset titles	X		
	• Equipment and performance specifications	X		
	• Training requirements, schedules, restrictions, and costs	X		
	• Other contracts	X		

Version 4 – Advanced Human Interface

This version of the AMS is characterized by the addition of visual interface components that give end users a variety of graphical manipulation capabilities. These include the ability to view interactive network maps from different perspectives via pan and zoom features, use hyperlinks to navigate between screen objects and database contents, and zoom (drill down) from a macro level to an individual component level. This would include, for example, the ability to drill down from a network map to a specific carrier hotel to a space in the carrier hotel to a component in the space. These features are available on a variety of off-the-shelf utility software and it's likely that these features would be implemented via a set of API calls to a third party software component or a web service. It should be noted that the implementation of these capabilities implies a need to create visual representations of relevant networks and individual assets. Preferably, these representations will be stored as Binary Large Objects (BLOBs) or in some other form inside the table containing the base information for the assets

Highlights

- Allows users to locate assets by panning and zooming over an interactive map

  A variety of off-the-shelf tools might be used to provide full geographic information system capability for network mapping. Examples include ARCWeb (ESRI systems) that is used by the Georgia High-Speed Telecommunications Atlas, or the AutoDesk suite of GIS products.

- Allows "drill down" capability to the asset component level.

  This capability would connect assets found on a system map to be hyperlinked to asset information in a database. In addition, given that the underlying data structure supports bill-of-material asset decomposition (i.e., one asset can contain another asset) a visual image of an asset may have hyperlinks to other assets on its surface. This type of functionality is found in GE's SmallWorld application used at Lockheed-Martin.

- Mapping feature tied to the underlying database such that all asset information is viewable within the current view context

  Allows visual navigation through the asset database such that parent assets are visible when child assets are displayed so that the context of the navigation is maintained (i.e., users can see their navigation path).

- Uses Latt/Long coordinates or other geographical information to locate and view asset data

  All assets should locatable and navigable via latitude and longitude coordinates. These coordinates will be required when creating an asset.

- Supports network operating center functionality (particularly in network monitoring, configuration, and connectivity management)

  Network monitoring and configuration information will be included in the graphical interface such that alerts, routing, load, and other information will be represented in the network maps interface.

- Provides a visual method for inserting and deleting assets that interfaces with the underlying database

  The graphical interface will support basic asset functionality such as the insertion or deletion of an asset into the database. Thus, the interface will be fully integrated with the database.

Version 4 – Advanced Human Interface Summary

	Business Processes			
1	Asset Acquisition	X		
2	Asset Valuation	X		
3	Asset Inventory and Accountability	X		Limited number of types of assets
4	Asset Maintenance	X		
5	Asset Retirement	X		
6	Stewardship Assignment	X		
7	Participant Registration and Maintenance	X		
8	Asset Order	-		Fixed assets only
9	Network design and engineering	-		Fixed assets only
10	Asset Scheduling/"Order" Filling	-		Fixed assets only
11	Service Order Assurance and Business Continuity	-		Fixed assets only
12	"Order" Changes/Cancellation/Completion	-		Fixed assets only
13	Reporting	X		
14	Archiving	X		
	Best Practices			
	User Interface			
	• Secured web interface	X		
	• Web enabled forms and database maintenance	X		
	• Visual/graphic Interfaces	X		
	Business Process Support			
	• Workflow	-		Task list & calendar only
	• Depreciation/appreciation, leases, and taxes	X		
	• Asset life cycle management	X		
	• Asset schedule management	X		
	• Physical inventory support	X		
	• Integration with F/A, A/P, A/R, and ERP systems	X		
	• Supplier and procurement management	X		
	• Customer billing	X		
	• Integrated service management	X		
	Data Management			
	• Database integration	X		
	• Disaster recovery	X		
	• Standard reports and queries	X		
	Network Management			
	• Network asset auto discovery		X	
	• Configuration and change management		X	
	• Help (service) desk consolidation	-		Fixed assets only
	Document and Contract Management			
	• License compliance tracking and audit mitigation	X		
	• Contract and lease management	X		
	• Warranty, maintenance management	X		
	• Building and floor plans	X		
	• Insurance policies	X		
	• Liens and lien waivers	X		
	• Physical and logical bandwidth topology		X	
	• Testing results	X		
	• Asset titles	X		
	• Equipment and performance specifications	X		
	• Training requirements, schedules, restrictions, and costs	X		
	• Other contracts	X		

Version 5 – Network Operating Center (NOC)

This version assumes that sufficient assets have been obtained that would require connectivity management, provisioning, integration, and deployment of IT assets. A major objective of the NOC architecture is the support of rapid fulfillment of connectivity requests. For example, a middle school in California might request video connectivity to a similar school in Japan and have the request satisfied within hours or minutes. In addition, the NOC would have all of the standard capabilities including auto-discovery of network assets, performance monitoring, dependency analysis, visual mapping/reporting, multicast support, and various levels of integration with outside networks and assets.

Highlights

- Auto-discovery of network assets via SNMP

  This function uses Simple Network Management Protocol to discover assets as they are added to the network. Note that these are assets that are active network components. Third party examples include WhatsUp (from Ipswitch Software) or SMARTS (System Management ARTS, Inc.).

- Help desk support for network related issues

  This function fully integrates help desk support with network management. It includes the creation of service tickets, dispatch, service tracking, and resolution reporting. A third party example would be Xanadu from Peregrine Systems.

- Network configuration support

  This function allows for the configuration of network assets. It would include

  o the scheduling of bandwidth by node or globally
  o display of network parameters
  o traffic measurement and control
  o routing assignment, control, and optimization
  o external asset information (a telco or other service provider asset info) to be used as part of connectivity configuration

- Network performance summary reports and a Web based network "weather map"

  This function is a publicly available web-based display of network usage and is a real time visualization of network conditions using color and popup windows to display device loads and related factors. The map is primarily used to apprise users of current network conditions. An example of this type of functionality would be the Indiana University Abilene NOC Weathermap.

Version 5 – Network Operating Center Summary

	Business Processes			
1	Asset Acquisition	X		
2	Asset Valuation	X		
3	Asset Inventory and Accountability	X		Limited number of types of assets
4	Asset Maintenance	X		
5	Asset Retirement	X		
6	Stewardship Assignment	X		
7	Participant Registration and Maintenance	X		
8	Asset Order	X		
9	Network design and engineering	X		
10	Asset Scheduling/"Order" Filling	X		
11	Service Order Assurance and Business Continuity	X		
12	"Order" Changes/Cancellation/Completion	X		
13	Reporting	X		
14	Archiving	X		
	Best Practices			
	User Interface	X		
	• Secured web interface	X		
	• Web enabled forms and database maintenance	X		
	• Visual/graphic Interfaces	X		Full GIS capability
	Business Process Support			
	• Workflow	X		Full workflow any type of asset (fixed or configured)
	• Depreciation/appreciation, leases, and taxes	X		
	• Asset life cycle management	X		
	• Asset schedule management	X		
	• Physical inventory support	X		
	• Integration with F/A, A/P, A/R, and ERP systems	X		
	• Supplier and procurement management	X		
	• Customer billing	X		
	• Integrated service management	X		
	Data Management			
	• Database integration	X		
	• Disaster recovery	X		
	• Standard reports and queries	X		
	Network Management			
	• Network asset auto discovery	X		
	• Configuration and change management	X		
	• Help (service) desk consolidation	X		
	Document and Contract Management			
	• License compliance tracking and audit mitigation	X		
	• Contract and lease management	X		
	• Warranty, maintenance management	X		
	• Building and floor plans	X		
	• Insurance policies	X		
	• Liens and lien waivers	X		
	• Physical and logical bandwidth topology	X		
	• Testing results	X		
	• Asset titles	X		
	• Equipment and performance specifications	X		
	• Training requirements, schedules, restrictions, and costs	X		
	• Other contracts	X		

System Architecture Summary

The concept behind the creation of the AMS is daunting. Essentially, the charge of this project was the creation of a set of specifications for a system that seamlessly blends management and engineering capabilities to provide affiliates with high levels of service and to maximize the use of donated assets. The envisaged system is a combined asset management, financial control, and network-operating center.

The proposed architecture consisted of 5 versions of increasing functionality. The reasoning behind this approach was to emphasize key changes in the architecture over time. It was felt that the major transitions in the development of the system would be the creation of an interface to outside systems, the addition of advanced graphical capability, and the creation of a NOC that would likely require high levels of integration with other systems. These segments appeared to be natural breakpoints in the development effort.

There are many possible paths in the creation of the system. The authors believe that the most realistic approach to reaching the goals described in the architecture would be to adhere to the following guidelines-

1. Where possible, incorporate off-the-shelf software to provide necessary functionality

   The complexity of system components dictates that it's unlikely, given funding and time, that success could be achieved through much customization. The integration of outside software components leverages their specialization and maturity, and reduces risk.

2. Develop web functionality at the outset

   By its nature, a telecommunications asset management system implies the need for distributed network access. A fully web based ASM allows custom delivery of functionality regardless of time or place and, thus, is essential.

3. Use state-of-the-art technologies

   Many of the complexities of systems integration with the accompanying need for data interchange can be mitigated by the use of the following new technologies-

   a. Web Portal

      A web portal is a web application that provides a common view of a collection of web resources. Each resource can be independently configured and may originate from anywhere on the web. Thus, it's possible to divide the portal view into sub views consisting of asset inventory, connections to outside systems, and a network map. In addition, web portal tools make it easier to create sub views, access diverse web resources, and enable authentication and security.

   b. XML

      Clearly, XML solutions should be explored for all data interchanges to outside systems, creating network configurations that are viewable and transferable to other parts of the system, and even the representation of asset data itself. XML is the lingua franca of data on the web and it should be considered in any implementation of an AMS. The primary benefit of XML is that it represents a powerful tool for standardization of communication between systems. Most major DBMS's have XML translators and most software vendors are moving to XML as a middleware solution to data exchange with other systems.

   c. Web Services

      Web services share business logic, data and processes through a programmatic interface across a network. The use of a web service approach should be considered in AMS development. Custom services could be created for certain core aspects of the system (asset/donor/affiliate/steward maintenance, for example) and outside web services could be used (purchasing or network mapping for example). The AMS could be entirely architected using

web services as the central paradigm. Web services allow different applications from different sources to communicate with each other without time-consuming custom coding, and because all communication is in XML, Web services are not tied to any one operating system or programming language. For example, Java can talk with Perl, Windows applications can talk with UNIX applications.

Pitfalls, Constraints, Recommendations

Funding:

Critical to the continued design, development, and implementation of the Asset Management System is obtaining a source of sufficient funding. The 2001/2002 ONR grant funds of approximately $100,000 provided adequate seed money for research and the simple prototype. Future progress will be constrained by available funding. It can be expected that annual funding in the future will need to be in the range of $1,000,000 for system development, software and hardware procurement, and maintenance.

It is recommended consideration be given to submission of independent grant proposals. The Office of Naval Research has expressed interest in this project and its outcomes such that additional support in the form of grant funding is possible.

Staffing:

Continuity of technical AMS project leadership knowledgeable in the business processes and operations of asset management practices, current and emerging information technology, telecommunications networking, and the IEEAF business model is essential. Significant and beneficial progress has been made in the last year with three part-time staff; the AMS project and implementation of the business plan will necessarily regress with the departure of at least two and possibly all three of these individuals.

It is recommended consideration be given to hiring or entering into a longer-term contract for an AMS project leader that can provide continuity and retention of the "business process model" for future AMS development.

IEEAF Business Model:

The IEEAF Business Model has provided a broad foundation for the first year's effort. It cannot be certain that the business practices and processes they will employ would satisfy a broader AMS clientele.

It is recommended that consideration be given to researching and analyzing other business models to support the most extensive telecommunications provider base possible.

The Asset Management Project team has worked closely with Jerry Hanley, IEEAF Treasurer and Asset Manager to gain knowledge of the business model, processes, and practices to be implemented by the IEEAF. He has complied consistently with a vision and a strategy that has guided the research and prototype development of this project. It is a concern that some of the business model, processes, and practices for managing the assets including a participant web-interface for scheduling and committing assets and the support of a global Network Operating Center have not been acted upon directly by the IEEAF Board of Directors.

It is recommended that the IEEAF develop and document its business model, processes, and practices for its own clarification and to solidify the scope of the AMS project.

AMS Prototype Maintenance and Support:

The prototype was originally visualized as the automation of a set of "index cards" with the relevant telecommunications asset attributes required to record and track a small set of assets (see Section 2 for

a full description of the prototype capabilities). The scope was expanded to also record and track Donors, gifts, Donor-to-gift link, asset-to-gift links, Asset Stewards, asset-to-Steward assignments, Participants, and associated documents. Implementation and use of the prototype is anticipated to result in required changes:

- The attributes associated with the assets can vary depending on the asset itself. With the support of GEO staff, the technical attributes of five distinct kinds of assets have been defined. Acceptance of the first asset outside this group of five will require modifications to at least one data entry form and database table additions.
- The attributes defined in the prototype are unproven and likely to require adds, changes, and deletes.
- Procured assets and recording of needed data from procurements handled by the Financial Services provider have not been fully addressed including identification of the vendor, shipping information, etc.
- Time restricted functionality; asset relationships (connections to other assets or the "bill-of-material" concept) have not been developed.
- Ad hoc inquiries and reporting development.

Consideration should be given to the identification of technical support in the form of a System Administrator for the prototype in a production setting. The responsibilities of the System Administrator could be united with those of the Project Leader for the short term.

AMS Data Entry and Maintenance:

The business processes and interface for data preparation, integrity, entry and maintenance of Asset Stewards, Participants, and the assets is not currently well defined:

- Obtaining data initially and continuing data integrity are a major concern. The AMS Project team learned this was a primary issue for the Arena Pathfinder capability on the Internet2 site. Responsibility for recording the initial asset attributes and for maintaining the data integrity by submission of changes has not been determined. Invalid or outdated information is as bad or worse than no data.
- The prototype database does not have a web interface for the data entry via a forms interface.
- The data entry forms are being delivered as Word documents intended for use as HTML forms. Some areas of the forms contain groups of data that can be repeating and must be duplicated.
- No individual or group has been identified or charged with the responsibility for assuring the data is collected, entered, and maintained in the prototype database. The forms (as described above) must be transmitted to someone with this responsibility.
- The prototype is designed for a single workstation.

It is recommended consideration be given to the definition and adoption of a process that assigns responsibility for providing initial asset attributes with the donor of the asset or the Asset Steward in the case of procured assets and on-going responsibility for the data maintenance with the Asset Steward. Until such time as a web interface is provided, one entity within the telecommunications provider organization should be assigned responsibility for collecting the completed forms, entering, and maintaining the data. That responsibility also could be united with the responsibilities of the Project Leader for the short term.

Asset Management/ Web Site Integration:

As the development of the AMS evolves, the integration with the telecommunications provider's web site is imperative. Timely implementation of AMS changes affecting stakeholders will become increasingly important to support connectivity services, maintain data integrity, and protect the privacy and security of all stakeholders.

It is recommended consideration be given to uniting the entities supporting the telecommunications provider's web site and the AMS under a single service provider to insure priorities to meet the AMS

project objectives are congruent and that service provider should, ideally, be within the scope of the Asset Manager's responsibilities.

Document Management:

It is anticipated that a large number of documents will be associated with the assets (leases, IRUs, warranties, service agreements, stewardship agreements, drawings, technical specifications, etc). The Asset Management prototype has anticipated this and allows for recording the type of document, its location, and relevant expiration or termination dates.

With the global nature of the network and the AMS stakeholders, consideration should be given to the procurement of a document management system with a web interface for direct access to the content of the documents.

Network Connectivity:

To address the needs of the educational community for telecommunications access to high bandwidth, it is more than likely connectivity between IEEAF owned or controlled assets with assets owned by other providers and by the educational entities the IEEAF serves will be required.

Responsibility for network design and engineering and defining and implementing the physical and logical connectivity needs to be determined by the IEEAF. Gathering the data from external providers to display the full complement of bandwidth and connectivity may prove to be impossible. The minimum set of data for non-IEEAF owned links needs to be defined.

Intellectual Property Rights:

The Asset Management Project set out with three primary objectives:
- to obtain and develop a knowledgebase in managing a global telecommunications network,
- to develop a working prototype application to support recording and tracking the telecommunications assets with the IEEAF as a model, and
- to determine the opportunities for creating a "Center of Excellence" faculty and student research in the related technologies and management of a global Network Operating Center.

The opportunity to achieve these goals was afforded through a grant award by the Office of Naval Research solicitation BAA00-018 (CPSU Grant Proposal Number 02-007) entitled "California Central Coast Research Partnership" to the Research and Graduate Programs office at California Polytechnic State University, San Luis Obispo, California.

As the recipient, administrator, and sponsor of this research project, Cal Poly should act to secure the Intellectual Property rights to the results of this project and especially the prototype application. The prototype has attributes unique to it and could conceivably be protected by virtue of obtaining a copyright.

Research Park Center of Excellence

An important consideration in the work described in this report is that it would form the basis for the creation of a "Center of Excellence in Telecommunications Asset Management" with an affiliation to the California Central Coast Research Partnership (C³RP) and the planned technology park. The C³RP is a non-profit coalition representing businesses throughout San Luis Obispo County and Cal Poly State University. Since 1997, C³RP has been involved in the development of a mutually beneficial partnership between Cal Poly and the private sector and is committed to expanding that partnership to include the entire San Luis Obispo region.

It would be the intent of a Center of Excellence in Telecommunications Asset Management to address these complexities outlined starting on page 7 (The Problem) of this report via research and operational activities.

The Business Case for a Center of Excellence in Telecommunications Asset Management at Cal Poly

Cal Poly has a unique set of capabilities needed for applied technology research and development in telecommunications asset management. They are summarized as follows-

1. Cal Poly has a large technically oriented cohort of faculty and students within the College of Business and the College of Engineering

2. Cal Poly has strong ties with Silicon Valley technology companies including Cisco, Sun, and Oracle

3. The Cal Poly Orfalea College of Business has recognized accounting, legal, and information systems programs with strong ties to industry.

4. Cal Poly is currently connected to the 23-campus Cal State University system via redundant north and south ATM OC12 (622MB) circuits.

5. Cal Poly is the major node feeding the San Luis Obispo County Office of Education for the Digital California Project (DCP), which directly links off Cal Poly fiber-optic cables at gigabit speeds.

6. Cal Poly has recently joined Internet2 (Oct 15, 2001) via CalRen-2 to the Abilene gigabit network and has begun planning strategic Internet2 initiatives for campus research applications.

7. Cal Poly has been named as one of the three major nodes (gigapops) for the new ONI (Optical Network Initiative) project.

8. The unique location of Cal Poly on the central coast of California creates the opportunity for the University to become a key player in the Pacific Rim / Asia undersea cable landings in Morro Bay and Los Osos.

9. Cal Poly is part of 4CNet (California State University and Community College Network) which will link all Cal State Universities and Community Colleges

Thus, Cal Poly contains the right mix of faculty, student, administrative, physical, and technical resources to make it an ideal site for the center.

Benefits to Faculty

Cal Poly faculty typically conducts applied research. Currently, the College of Business and the College of Engineering have faculty with proven research track records in telecommunications infrastructure development, applied artificial intelligence, asset accounting, forecasting, econometric modeling, simulation, software engineering, the legal aspects of intellectual property, and supply chain management systems. A "Center of Excellence in Telecommunications Asset Management" would provide an outlet for their research, a source of collaboration with other faculty, and an opportunity to develop new ideas in the modeling, management, and processes in this emergent and complex area.

Benefits to Students

Cal Poly students are motivated by a desire to exercise a "hands on" approach to the solution of real problems. Although connections with industry are significant, Cal Poly's location on the relatively isolated central coast of California precludes the type of cooperative industry relationships found in urban universities. Thus, a "Center of Excellence in Telecommunications Asset Management" would provide students with a local opportunity in the areas of software development, operations management, financial, accounting, econometric modeling, project management, requirements and systems analysis, as well as many other important skills.

Benefits to the Curriculum at Cal Poly

Cal Poly has an innovative curriculum in the technical aspects of telecommunications; however, currently, no courses exist in such areas as telecommunications management, virtual asset accounting, the intellectual property implications of new telecommunications technologies, and network modeling and simulation. The envisaged asset management system ultimately includes a network operations center that could be used as a test bed for the development of a program in network operations management that would include both the managerial and technical aspects and could be a joint venture between the College of Business and the College of Engineering. Since these colleges now offer a joint program in Engineering Management as part of the MBA program, a stream might be offered in the area of network operations management.

Research Possibilities

Part of the work of the project team was to suggest future research directions for the effort that would enhance the quality of the system and provide research opportunities for faculty and students. The following were submitted as potential research projects.

1. **Advanced asset management tool creation**

   The creation of advanced telecommunications asset management tools in the areas of visualization, performance monitoring, scheduling, network simulation/modeling, financial modeling, data representation and data access.

2. **The use of ontological representation and reasoning to acquire, model, and manage asset and network knowledge**

   The representation of telecommunications assets and networks requires a daunting array of attributes and knowledge. For example, a donation of dark fiber contains over 61 data elements and involves knowledge about the fiber itself, pass through devices, testing procedures, quality of service metrics and processes, as well as a collection of accounting and legal information. In addition, networks themselves are a rich assortment of devices, connections, performance and accounting data and other information. Ontological representation and reasoning has been successfully employed in the past as a means of deriving information from complex problem domains consisting of large collections of disparate data. Ontological approaches are seen as a mechanism to move from data to information to knowledge. An effective ontological representation of asset and network knowledge would allow users to answer complex knowledge-related queries not normally answerable with traditional database methods. The technique involves the creation of a lexicon of keywords, a set of relations among the words, and a process for applying reasoning on the set of words and relationships.

3. **The use of intelligent agent software based techniques to support telecommunications asset management**

Intelligent agent technology offers a solution to a variety of problems found in telecommunications asset management. Intelligent agents are processes that operate in the application background and can be used for the sensing, monitoring and control of specific application parameters. Their actions may be guided by ontological reasoning (described above), a rule-based expert system, or a neural network. They provide advanced intelligence capability normally exercised by human judgment. However, unlike humans, agents can operate in a 24/7, real time mode, act in concert with other agents to provide increased intelligence, and react appropriately to complex events.

Potential applications in the Telecommunications Asset Management area that are applicable include:
  - o Workflow: events triggered by certain activities or time such as recognizing donors, renewing contracts, or activating a network connection,
  - o Network design and engineering: based on physical asset data and a knowledge base of telecommunications and networks connectivity, existing connections and open available resources,
  - o Network loads and routing: based on traffic and alternate available routes,
  - o Network management: fault detection and alerts, help desk support for asset failures,
  - o Asset scheduling and logical network: determination of routing to meet client established parameters including time and knowledge of network assets and other network commitments including a user interface that displays viability and routing of request,
  - o Network planning: technology advances, utilization of current capacity, and
  - o Auto discovery: based on asset parameters, recognition, identification and integration of new or changed asset configurations.
  - o Asset capture: asset data and knowledge about assets could be intelligently captured. Ex. System knowledge about an asset class would narrowly focus data entry only to data required for a particular class (ex. a very specific type of dark fiber or carrier hotel space). In addition, data entry could be intelligently validated.
  - o Asset information dissemination: Information about assets could be distributed based on their individual need-to-know characteristics as defined in an ontology. An agent would be responsible for insuring proper notification.
  - o Asset maintenance: Asset knowledge combined with the use of maintenance agents could provide a full range of maintenance functionality... reporting, scheduling, monitoring, notifying, etc.

4. **The use of XML as a middleware approach to the representation of asset and network information**

A Telecommunications Bandwidth Manager is charged with handling an unknown set of telecommunications assets. Thus, the use of traditional fixed attribute database techniques is limited since many attributes are never known beforehand. The use of Extensible Markup Language (XML) for the creation of on-the-fly, freeform, searchable XML pages offers a potential solution. The pages could contain large indexable and searchable text fields combined with a relatively fixed set of high level meta tags (ex., OWNER, LOCATION, CONTRACTID, etc.). XML encapsulated data has the advantage of being readable in a browser, transferable to other applications, storable in some DBMS's, standardized, and flexible. In addition, the technique might be employed with the ontological approach noted above.

5. **The use of a rule-based expert system with a web front end to capture complex telecommunications asset information efficiently**

A clear message from the asset management work done to date is that the data capture processes is complex. For example, the capture of donation information for dark fiber (as described in 1 above) might be done effectively via a series of questions driven by an underlying rule base in a web-based

application. This would limit the number of questions needed to obtain the data and the data could be captured immediately.

6. **The use of a web-based document management system to capture information centrally and display it on the web.**

Much of the effort handled by a Telecommunications Asset Manager is document based and many documents require signatures. A web-based document management system might be developed that centrally captures document images via a digital scanner, stores the images (along with meta tags) on a document server, allows selected users web access to the images, and provides a web front end with hyperlinks and search capability.

Attachments

Attachment A

IEEAF "Vision" and "Key Operations and Activities"

Vision:

We share a vision intended to accelerate the growth of Internet2™ such that it:

- Enables and stimulates the rapid expansion of educational collaboration in many forms between and among teaching and learning institutions across the world.
- Cultivates and promotes practical solutions to delivering scalable, universally available and equitable means of access to suitable bandwidth and the necessary network resources in support of these collaborations.

To achieve this vision we intend to create frameworks and alliances between University and other educational leadership groups as well as key Corporate partners such that:

- Prudent strategies are advanced to secure and leverage network-related assets, and to capitalize on events associated with the build-out of the global submarine and terrestrial fiber optics networks
- A spirit of wise stewardship is created to secure, leverage and deploy both the assets themselves and the equal and fair use of the bandwidth available from these assets for a broad range of educational purposes
- Creative and flexible governance structures and processes are devised to ensure the most responsive results are achieved in the use of these assets and
- These structures and processes are capable of continuously managing these resources to serve the broadest of global, national, and institutional priorities for educational access; be they at the University, secondary, or elementary levels as our efforts evolve and achieve success.

Further, we believe that we can create both the infrastructure and incentives to encourage the expansion of innovation and the means to promote stronger ties between educational institutions, industry and national leaders by stimulating the development of programs and activities that:

- Mentor and develop the human potential of our students
- Expand the technical skill development and employability of our students
- Broaden the means for faculty to conduct bandwidth intensive research and instruction
- Reduce the potential that "less than universal access" to important educational resources remains a barrier for some in the new millennium
- Nurture new opportunities for job creation and productivity growth made possible by such connectivity

Activities and Operations:

1. Act to insure enhanced educational access to bandwidth for educational institutions and their academic, research and services uses by provisioning connectivity of network assets, facilities, space and resources.

    *   Develop means to secure, collect and make available donated and "in-kind" services for these purposes

    *   The IEEA Foundation expects that on a limited basis and not as a direct result of the intent of its mission that there may be certain assets, particularly space, and physical transmission facilities which may be donated in excess of current or localized needs. Accordingly, IEEA may attempt to also place such incidental and temporary surplus assets into use to generate rents or associated income from the public or commercial interests so as to create some financial benefit for the Foundation's not-for-profit activities. Such dealings will be incidental to the core activities of the Foundation but if/as they occur they will be reported fully as part of an annual tax return and/ or will be moved into a separate subsidiary whose purpose will be to derive some productive use of these assets until such time as they can be placed into service for Educational ends. Distance learning connections and filling in missing links between existing educational networks are two typical activities to illustrate this set of activities

2. Promote Partnerships with government / private entities and educational institutions to facilitate education in communities, and across states, governments and like-minded educational and political institutions

    *   Promote public partnerships and regulatory rules and conditions to facilitate and encourage action and to inform the public on key issues that relate to educational access, the most efficient means to promote global connectivity and collaborations of "cyber-learning", "e-learning", and efficient means for distributing educational content across networks, nations and on a truly global basis.

        The IEEAF operates in the larger context of the extensive US and global educational community which today has formed or is forming extensive local and regional partnerships and "networks" to bring together and at times operate internet and communications resources from within their state(s) or region(s) and to create larger scale connectivity and efficiencies for their members and users.

        Such groups may form Foundations or consortia such as UCAID, CENIC, SURA, "the Quilt", etc. to perform or deliver services suited to their own member institutions, users or subscribers in the context of the teaching and learning communities of which they are themselves participants or for which they were formed to serve.

3. Provide and/or operate a low cost/efficient reliable set of access and network resources and information or productivity tools to achieve these capabilities for educational purpose

    *   The IEEA Foundation plans to receive donations of space and licenses to "rights of way", and facilities; e.g. "dark fiber" at selected points of build-out of the US and global fiber-optical network. Such donations will be a principal means of connectivity and linkage for educational institutions to conduct teaching and learning. Key activities of the IEEA will be to integrate such assets and space / rights of way such that real connectivity and benefits can be established that promote low cost educational access. The IEEA will design and operate key aspects of such utilization efforts including inventorying and tracking the locations, access and best uses of these facilities and offering connectivity to schools, colleges and learners. We will also, as the need arises, seek to recover some of the costs to provide these services to member institutions either by charging fees to our

members or associated educational users or by instituting some direct charges tied to their educational usage.

>The cost recovery mechanisms to be applied will be strictly based on an assignable direct loaded cost basis per asset or project or facility in the case of floor space or like real estate assets.

- IEEAF intends to create Affiliates who can abide by and adhere to the IEEAF's intent and its purposes to place these assets into useful educational service. These Affiliates will enter into "stewardship agreements" (q.v.) with IEEAF that will place into the Affiliates' operational control assets (real estate / building space, fiber channels, conduit, rights-of-way, etc.) to be used for the purposes for which these donated assets were received by IEEAF. IEEAF will in such stewardship agreements require Affiliates to place and maintain specified assets under *licenses of use* from IEEAF within their area of operation or service and as part of these agreements and licenses require Affiliates to reimburse IEEAF on a strictly cost recovery basis real costs that IEEAF incurs to receive, and to maintain and to place such assets into useful purposes."

A fundamental intent of the IEEAF is to lower the costs of bandwidth and connectivity for educational purposes. But there is a coincident intent to have this bandwidth and access available to all institutions that have an educational purpose wherever we can reach them. The stewardship agreements will require that this occur as the resources donated to IEEAF are placed into service. The identification of and selection of such potential stewards will be dependant on their location and capabilities to perform and act on this intent. But the basis for reimbursement by stewards to IEEAF for any costs will be strictly determined on the actual direct loaded costs to place and maintain the assets.

There are no schedules for fees/rents, all costs that are incurred by affiliated "stewards" will be determined on the basis of and fully supported by direct assignable cost to place the specified assets into service and or/ to maintain and support such assets for useful educational purposes.

>This approach will enable the IEEAF to leverage the regional and local "scale" of professional staff and technical skills from designated IEEAF stewards thus lowering total costs and incenting IEEAF and the stewardship partners to focus on minimizing or avoiding duplicative efforts.

4. Develop an efficient framework, principles and operational procedures to perform Asset Management for the Foundation, its members and associates on a global basis to encourage large-scale donations and utilization of useful access and network resources for educational purposes.

There is a need for a truly global educational infrastructure and the means to insure that it serves the public interests. IEEA will conduct research and promote collaborations and symposia to achieve progress towards efficient and ubiquitous linkages and to encourage current commercial investors to contribute as part of their new investments and construction to donate spare capacity to serve educational usefulness.

5. Design and operate key aspects of network utilization including inventory and tracking of locations, access and best uses of donated facilities in offering equal access and connectivity for education.

Attachment B: Detailed Asset Descriptors

ollowing set of telecommunications attributes was provided to the IEEAF by Geo Corporate staff.

1) Dark Fiber

A detailed network topology of the fiber route including:
Number of fibers & their lengths
Detailed fiber pair numbering within the cable route.
Detailed physical route topology.
Determine point to point or ring topology
Define restoration path or diversity.
Determine number of splice points / junction boxes / connection points.
Specify fiber manufacturer and type of fiber G652, G655, LEAF, etc., for all segments. Specification of the fiber.
Determine age of fiber.
Obtain all inaugural test results including wavelength dispersion (see Testing Procedures & Results attachment)
Determine if fiber is buried within duct or direct burial
For direct burial, determine if the fiber is armored or protected by a sheath.
Define any Aerial segments
Determine ODF positions and number of patches within the given route.
Span tolerances and span distances
Define Service Level Agreement
Determine if repair of the physical plant is included
Determine Mean time for repair of fiber cuts.
Determine Mean time for repair of duct cuts.
Determine if secondary routes will be patched through in a fault scenario.
Track method for determining number of cuts and repair actions.
Tracking of new test results to establish degradation of service due to cuts, etc.
Fiber Duct/Conduit
Determine type/material and size of duct.
Determine the age of duct.
Determine depth buried.
Establish if other ducts on the same trench
Determine who owns the right of way and who can access the trench
Determine if others own fiber, conduit, inner ducts, within same trench
Determine if others can build or have built in the same right of way
Determine if other right of ways cross over or near the dust route
Define number of break out points (hand holes / laterals / vaults)
Define SLA for the duct
Terms and conditions of use
Length of allowed use
Any "take back" provisions
Splice locations
Number, scope, type and location of equipment sites used to pass through (Repeaters, ILA, Drop and Inserts, DREIs, etc.)
Termination locations and termination types by location
Terminating and collocating at termination points of donating party?
Does donation include rack and cabinet space to terminate dark fibers?
What are the terms and conditions for lighting the donated dark fibers?
Is space being made available for this and under what terms and conditions?
What environmentals are included in the provision of space and under what terms and conditions?
What is the reliability on power and what type of emergency power generation is available and under what terms and conditions?
What provisions are there to exit and receive the dark fiber at the termination locations?

If not, what are the termination responsibilities of the recipients?
Access provisions and restrictions to accessing the dark fiber
Any escort requirements?
Network surveillance and alarming program
Maintenance program
Restoration program with response time and escalation procedures
Spare fiber, equipment and conduit availability
Relocation program
Rights of way used
Title review
Right of way compensations paid/type
Right of way surveillance program
Right of way non-disturbance protections
Utility Locate and One Call programs and memberships
Insurance program
Liens and lien waivers (both on equipment and contractors' work)

2) Managed bandwidth (Sonet or TDM)

Detail the physical and logical topology of the capacity
Determine the restoration plan for the capacity
Define the attributes of the network that the capacity runs over (fiber/ copper / hybrid / meshed / SONET ring / folded ring, etc)
Define level of network maintenance (MTTR, MTBF, etc.)
Define trouble reporting procedure and escalation procedures
Define periodic maintenance plan and outage planning notification procedures
Terms and conditions of use
Length of allowed use
Any "take back" provisions
Network routing of any managed bandwidth donation.
Number and scope of equipment sites used to pass through.
Equipment requirements at the end user end points.
Framing used
Network monitoring and surveillance
Network redundancy characteristics

3) Wavelengths (unprotected/pre-emptible)

Define the size of capacity and conditions for use (unprotected / pre-emptible / etc)
Detail the parameters covered in managed bandwidth
Define transport fiber parameters and characteristics as outlined in dark fiber section
Determine wavelength color numbering scheme
Define DWDM equipment and any optical switches
Define SLA
Determine restoration plan, if applicable
Terms and conditions of use
Length of allowed use
Any "take back" provisions
Network routing of wavelengths donated.
Number and scope of equipment sites used to pass through
Equipment requirements at the end user end points
Framed or unframed characteristics
Network monitoring and surveillance
Extent of preemption and terms of the preemption
Are there options available to the IEEAF to protect waves?

4) Accommodations/Carrier Hotel

Determine the physical condition of the space (improved / shell and core)
Determine number of rack spaces or total sq footage.
Obtain floor plans
Obtain lease conditions for all leases (subleases, master leases, etc.)
Define access arrangements to accommodation
Determine availability and provisions of power, HVAC, water, sewer, fire protection, security, and any other utilities and services
Determine level of maintenance/ provisioning/ implementation included and available on site and hours of operation
Determine call out procedures and any costs associated with dispatches
Determine level of expertise and any associated costs
Determine carrier connectivity and access to "meet me rooms" and any fees associated with cross connects or access to these connections or facilities
If improved rack space is provided:
Determine if racks will be in a caged/controlled access environment
Determine the power available to each rack and type (AC/DC, single/dual path)
Determine cooling and power density
Determine if racks/cabinets are provided and the dimensions
Determine rack/cabinet type/manufacturer
Determine access to cable troughs for fiber, control cables, cooper, power, etc.
Determine type of fire protection and discharge considerations
Define maintenance plans for all infrastructure systems and sub systems
Determine back-up systems for power, HVAC, security, fire protection, etc. and system reliability factors
Determine Service Level agreement for collocation
Terms and conditions of use
Type of occupancy right donated
Lease, license, permit or other
Length of allowed use
Any "take back" provisions
Amount of square footage. Usable verses rentable.
Underlying landlord and financial institution lien holder
Type of space. Floor location
Is fiber access to space included?
Is third party fiber access allowed and under what terms?
Space specifications
Condition and any existing usable improvements
Ceiling height
Power availability and reliability
Emergency back-up power provisions
Floor loading
Fire suppression
Security and alarming
Any costs to the IEEAF on above items. If so, how paid?
Physical access provisions and restrictions in accessing the space
Is any escort required?
Are there maintenance costs?
Are there common area costs?
Can first rights of refusal be given to the IEEAF to its protect occupancy in the event of tenant vacation?
Non-disturbance protections
Insurance
Liens and lien waivers (both on equipment and contractors' work)

5) Equipment Acquisition Checklist

1. Identification of Hardware System
   a. Equipment or performance specifications
   b. Equipment documentation
2. Title to Equipment
   a. Transfer of title upon shipment
   b. Risk of loss during shipment
   c. Vendor retains security interest?
3. Insurance during shipment
   a. User required to acquire insurance?
   b. Vendor obtains insurance at user's expense?
4. Environment
   a. Vendor specifications
   b. User prepares site at own expense?
   c. Vendor inspects user environment?
5. Installation
   a. Performed by vendor or user?
   b. Cost borne by whom?
6. Acceptance Procedure
   a. Use of vendor's standard acceptance test?
   b. Use of jointly developed acceptance test?
7. Training
   a. Scope and amount of training
   b. Qualifications of instructors
   c. Location of training sessions
   d. Restrictions on number of trainees
   e. Cost
8. Warranty
   a. Repair or replace
   b. Term of warranty
   c. Warranty commencement
   d. Disclaimers
9. Limitations of Liability
   a. Delays in delivery
   b. Damage Claim limitation
   c. Time restriction in bringing an action
10. Security Interest
   a. Rights to remove equipment
   b. Rights to file under UCC
11. Indemnity
   a. Vendor shall defend any suit based on infringement
   b. Notifications
   c. Vendor indemnity as to damages
   d. User cooperation in defense of litigation
   e. Pass through of warranties from sub-vendors
12. Performance Schedule
   a. Deadlines for deliveries, by subsystem
   b. Hardware acceptance tied to software acceptance
   c. Grace periods and effect of delays
   d. Penalties or liquidated damages
13. Documentation
   a. Number of copies of manuals
   b. Right to reproduce documentation
14. Maintenance
   a. Vendor to supply maintenance or provide services of third party
   b. Vendor to limit price increases
   c. Vendor to provide remedial or preventive maintenance

d. Terms; part costs (expendables, refurbished, replacement), exclusions
e. Response time
f. Response hours
g. Guarantee of assured maintenance for an extended term (e.g. 5 years)
15. Backup availability if equipment is down for extended term
16. Limitation of contract assignment
17. Force Majeure clause
18. Attorney fees in event of legal action
19. Governing law designated
20. Integration clause
21. Arbitration clause
22. Consent to suit in specific court

6) Combination –

For rack space/managed bandwidth combinations ensure applicable details for each category is satisfied.

Attachment C: Asset Management Business Processes

1. Asset Acquisition (Diagram 2)

Assets may be acquired in one of two ways: by donation or by procurement. Sub-processes support donor and gift management for donated assets and interfaces with the procurement process through the contracted financial accounting system. The donor management side of the process supports the databases maintaining donor, pledge, and gift information. Data will be replicated from the Financial Accounting System sufficient to support the management of procured assets within the Asset Management System.

2. Asset Valuation (Diagram 7)

Establishes and maintains over time the value of the asset, lifetime, and depreciation schedule or appreciation. Data must be sufficient to support annual financial statements, life cycle management of the asset, and other required reporting.

3. Asset Inventory and Accountability (Diagram 3)

Maintains the attributes of the assets including but not limited to physical, geographic, topology (connections to other assets forming networks), bill of material (drill down on components, e.g. racks within carrier hotel space, slots within racks, components on rack, boards in component, etc.), scheduling parameters, financial costs and income, operational status, support contacts, and restrictions and limitations placed on the use of the asset. It also supports periodic physical inventories and reconciliation.

4. Asset Maintenance (Diagram 3)

Supports the information relevant for repair and maintenance of each asset including agreements and their timely renegotiation, service work orders placed including changes in location, and maintenance history of the asset.

5. Asset Retirement (Diagram 4)

Supports the permanent removal of an asset from service due to contractual expiration or problematic maintenance history and disposal. Process must consider current customers of the asset and their support during transition.

6. Stewardship Assignment (Diagram 3)

Supports the assignment of a steward geographically close to the asset for local management and maintenance of the asset. Databases manage the stewardship agreement, asset-to-steward assignments, and steward contact information.

7. Participant Registration and Maintenance (Diagram 8)

Captures and maintains the "customer" information for both "Participant Affiliates" and "Non-Affiliated Participants" including administrative, technical, and financial contacts. Customer uses of the asset(s) are maintained and an accounts receivable interface with financial accounting system provider.

8. Asset Order (Diagram 6)

Captures the requirements of a "customer" for one or more bandwidth assets and the quantity of each. The unit of measure for each asset may fall anywhere within the drill down levels of the "bill of material" or the topology of a completed network (i.e. links between multiple sites). Information is solicited on academic purpose for utilization of the asset, primarily for reporting on "highest and best use".

9. Asset Configuration (Diagram 5)

This process may be required or not depending on the status and configurations of the existing asset base. It may be the responsibility of the customer or of the IEEAF depending on the specific asset(s) required and the current configuration. This process may establish new or changed relationships and connectivity among multiple assets to complete the specific requirements of the "customer". The process must take into consideration the current utilization of partially requisitioned assets by other customers.

10. Asset Scheduling/"Order" Filling (Diagram 6)

Determines the availability of the asset(s) for the term specified and schedules it. Cost recovery payments and schedules are established and participant (or Service Level) agreements maintained including failure consequences.

11. Service Order Assurance and Business Continuity (Diagram 6)

Provides customer service related to network connectivity and cost recovery billing during the period of the agreement. This may include network operations, network monitoring and management, and fault detection, isolation, and resolution. Typical operational areas supporting the business process include a Network Operations Center and Help Desk. Billings must be compiled for all assets currently utilized by each customer and consider whether the participant is affiliated or non-affiliated.

12. "Order" Changes/Cancellation/Completion (Diagram 6)

Process again must consider total utilization of the asset(s) by this customer and others to execute changes requests in configuration, lifetime of the asset for contract extensions, etc. Cancellations and completions of service place the asset(s) or portions thereof back into inventory for requisition by other customers.

13. Reporting (Diagrams 2 - 8)

Compilations of data to support financial and government agency reporting, "highest and best use" of asset use for both internal assessment and to encourage future donor support, performance assessment, customer satisfaction, etc. License compliance tracking and audit mitigation between customer and the IEEAF and the IEEAF and donors reporting capabilities should be considered a part of annual reporting.

14. Archiving (Diagrams 2 - 8)

Removing records from active database and storing for audit purposes.

Note that business processes must take into consideration compliance rules and regulations such as the FASBY federal accounting standards and possibly FCC telecommunications regulations.

Attachment D: Site Visit Reports

IUPUI Site Visit   **November 16, 2001**

Cal Poly Attendees:	Ken Griggs Jim Sena Joanne Temple
IUPUI Host: **Consultants:**	Brian Voss, Associate Vice President, Telecommunications Division Rob Quick, Global NOC Lead Operator Terry Usrey, Director, Telecommunications Tim Kelly, IUPUI Network Manager Richard Sammiis, IUB Network Manager David Jent, Manager, Network Engineering Jim Williams, Manager, Advanced Networking

NOC Operations

- Staff: 24 x 7, 2 – 12 hour shifts (S-W and Th-S), full time personnel, 14 staff total
- Responsible for network monitoring, determining point of failure origin, assigning problems, tracking, and user notification:
    o IU Statewide network
    o Abiliene/Internet2
    o Global Research Network
- Tools for Performance monitoring, problem and change management:
    o Weather map (locally developed software)
    o "What's Up", ping software
    o BGP session monitor
    o Router proxy
    o Problem and change management (locally developed, implementing Peregrine)

NOC Engineering

- Staff: 7-8 network engineers
- Responsible for:
    o Network engineering, configuration, and documentation
    o Network troubleshooting
    o Network maintenance and repair

Internet2 Operations

- UIPUI NOC; agreement with UCAID
- "connector" points support their own engineers and parts inventory; agreement with UCAID for support
- infrequent requirement for IUPUI to send an engineer out to handle a problem
- network data requirements include:
    o equipment and parts inventory
    o topology
    o circuits and circuit Ids
    o contacts
- data management:
    o currently manual with network data base in development for the Abiliene project (later will be generalized to support all networks under their management)
    o to include WEB interface
    o original design and development: technology environment: C, Oracle, and active server

- o will not include financial elements or participants
- o resources: 1 Sr. DBA, .5 Jr. developer, network engineer consultants
- Cisco Systems provide core routing technology
- Network software environment;
  - o NETSYNC
  - o What's Up
  - o Cisco and/or Juniper
  - o ARPMAN (harvesting data)

Data model attributes:
- asset maintenance contracts: warranty agreements, contacts, location (change of location) and notification, expiration date, terms and conditions
- asset inventory including spare parts
- topology
- circuits, circuit IDs
- remote node contacts

Follow-Up Items:
- Network data base/Asset Management Data Model – Terry Usrey
- Asset Management Excel spreadsheet (URL) – Dave Jent
- UCAID Connector (SEG-P) Agreement – Heather Martin (of UCAID)
- UCAID Initiative for end-to-end performance; i.e. time and performance assurance
- COGENT model for marketing bandwidth in areas of high concentration
- SWITCH 'N DATA model for carrier hotel support (connections, maintenance, etc.)
- Internet2 "connector" model of network support
- Legal issues surrounding resale/bartering of network resources and requirement to be a "carrier"
- Model for "last mile" network design and engineering

Jerry side items
- IU Strategic Plan, resources, organizational structure
- $30M Lilly grant for six advanced student labs to act as "incubators"
- carrier hotel lessee considerations
- employee "on-call" compensation
- McRobbie status in IEEAF

Presentation and Tour of CAD Research Center
05/15/02

Attending: Ken Griggs
                     Jens Pohl
                     Jim Sean
                     Joanne Temple

Objective: To view the CAD research facilities on and off campus, to gain an understanding of the technology, and to develop a sense of how the technology can be applied to the future research and development of a Telecommunications Asset Management Application.

CAD Research background: Most of the work done by the research center to date has focused on battlefield simulations and ship loading simulations and other applications that support decision-making. In a nutshell, the CADRC is in the business of creating software that provides intelligent support for complex tasks. Originally, their work focused on the domain of physical space (in particular, ship loading) but has branched into higher-level activities in the areas of battlefield support, intelligence data synthesis, and logistics planning. They have successfully used student labor to create commercially viable products and they have a consistent track record of achievement in leading edge DOD related projects.

Application: The technology employs different types of agents: mentors, service, planning, facilitator, and human. None of the work currently underway in the research center directly addresses communications assets or the configuration or management thereof. There are, however, many analogies among the applications that they have developed. Research and development in this area comes at a cost: Jens indicated that for projects of this nature to be viable they require a core budget of approximately $1M per year.

Potential applications in the Telecommunications Asset Management area that immediately come to mind are:

1) Workflow: events triggered by certain activities or time such as recognizing donors, renewing contracts, or activating a network connection,
2) Network design and engineering: based on physical asset data and a knowledge base of telecommunications and networks connectivity, existing connections and open available resources,
3) Network loads and routing: based on traffic and alternate available routes,
4) Network management: fault detection and alerts, help desk support for asset failures,
5) Asset scheduling and logical network: determination of routing to meet client established parameters including time and knowledge of network assets and other network commitments including a user interface that displays viability and routing of request,
6) Network planning: technology advances, utilization of current capacity, and
7) Auto discovery: based on asset parameters, recognition, identification and integration of new or changed asset configurations.
8) Asset capture: asset data and knowledge about assets could be intelligently captured. Ex. System knowledge about an asset class would narrowly focus data entry only to data required for a particular class (ex. a very specific type of dark fiber or carrier hotel space). In addition, data entry could intelligently validated.
9) Asset information dissemination: Information about assets could be distributed based on their individual need-to-know characteristics as defined in ontology. An agent would be responsible for insuring proper notification.
10) Asset maintenance: Asset knowledge combined with the use of maintenance agents could provide a full range of maintenance functionality... reporting, scheduling, monitoring, notifying, etc.

Application of current asset management development: Fundamental to the technology is the capture and organization of the underlying data, i.e. the development currently underway. The version 1.0 solution organizes the data in typical database structures. It is not likely that this structure would meet the requirements for relating objects in meaningful ways but could be the basis for advancing to the next step. One critical aspect of the data definition is to ensure we have the right level of detail and do not store the data as "meaningless text strings" (quoted from "Transition from Data to Information" by Jens Pohl, PhD.).

The key element in the application of CADRC to IEEAF asset management is one of time and complexity. In the short run, asset management at the IEEAF is likely to consist of the capture and dissemination of donor, participant, steward, and asset information. This can be accomplished through traditional database and/or web techniques at varying levels of data granularity at a relatively small price. The value that could be added by the CADRC is the addition of intelligence to the process (as outlined above). For example, assets would not only carry data about themselves but would have intelligent links to donors, stewards, and other assets. Thus, they could be intelligently captured and configured on the fly with less time consuming human intervention. However, the addition of this capability comes with both a literal and figurative price. Not only would the process of encapsulating asset knowledge cost in financial terms but also in terms of time, complexity and commitment by staff on the project. A possible short term solution might be to partner with the CADRC for a limited, small proof-of-concept web based application that contains limited intelligence but would, at the very least allow for asset data to captured, managed, and disseminated. The CADRC has an internal group responsible for web site development that might be used for this purpose. This work would provide a base for future funded research and collaboration with the CADRC. It should be noted that the CADRC's work has general applicability to most problem domains. The work of the CADRC has great promise for large-scale funded research appropriate to the research park.

Recommendations by Jens Pohl:
- Build database using Oracle 9i
- Use Java as the development language
- Either NT or Unix could be used as the base platform